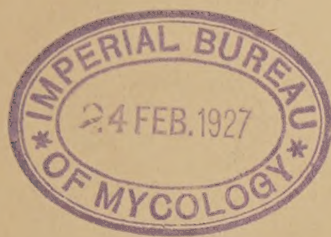


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EMPIRE COTTON GROWING CORPORATION



REPORTS RECEIVED FROM
EXPERIMENT STATIONS

1925-26

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LONDON

1927

**REPORTS RECEIVED FROM EXPERIMENT
STATIONS, 1925-1926**

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PREFACE

THE volume of Reports from Experiment Stations issued last year contained accounts of the work that was being done at five stations only. The present volume contains reports from nine stations, and from the Corporation's Seed Farm in Nigeria. The increase is not wholly due to expansion in the number of stations controlled by the Corporation, but is partly accounted for by the fact that it has been thought that it would be useful if accounts of the experimental work now being carried out on cotton in the different countries of the Empire could be collected, so far as possible, in one volume each year. The thanks of the Corporation are due to the Governments of the Commonwealth of Australia, the Sudan, and the Uganda Protectorate for permitting the inclusion of the Reports from those countries in this volume. In Australia and in the Sudan the research work has been aided from the funds of the Corporation, while the Cotton Botanist in Uganda was formerly a holder of one of the Corporation's Studentships.

In addition to the research described in the present volume, the Corporation has established a station in Trinidad; but the work there is directed primarily to the solution of fundamental scientific problems underlying the growth of the cotton plant rather than of those which are more particularly perhaps of local importance. It will accordingly be published separately elsewhere when the time arrives.

The Reports now included form a record of patient and industrious work often carried on under trying climatic conditions which have occasionally caused failure of the experiments, to the natural disappointment of the staff in charge. Much of the work has been directed towards the control of pests, the line of attack being mainly the breeding of resistant strains or the devising of means for trapping such pests at an early stage. In every country experiments are being carried out to discover which variety or varieties of cotton will prove most suitable to the prevailing conditions, and work along these lines cannot fail to produce its effect on the output of the various countries.

During the past year an Agricultural and Cotton Conference was held at Nairobi, which was attended by the officers in charge of most of the Corporation's Experiment Stations in East and South Africa. The full report of the Conference is not yet to hand, but ample evidence has been received to show that one of the results which it was intended to secure—namely, that of bringing members of the staff of the Corporation in touch with one another and with the agricultural officers of the Governments concerned—will greatly facilitate that informal interchange of information which is so difficult to secure among workers in tropical countries, and which is one of the most important factors in improving the quality of the work attempted.

QUEENSLAND

REPORT ON THE WORK OF THE CALLIDE COTTON RESEARCH STATION, BILOELA, FOR THE YEAR ENDING JUNE 30, 1926

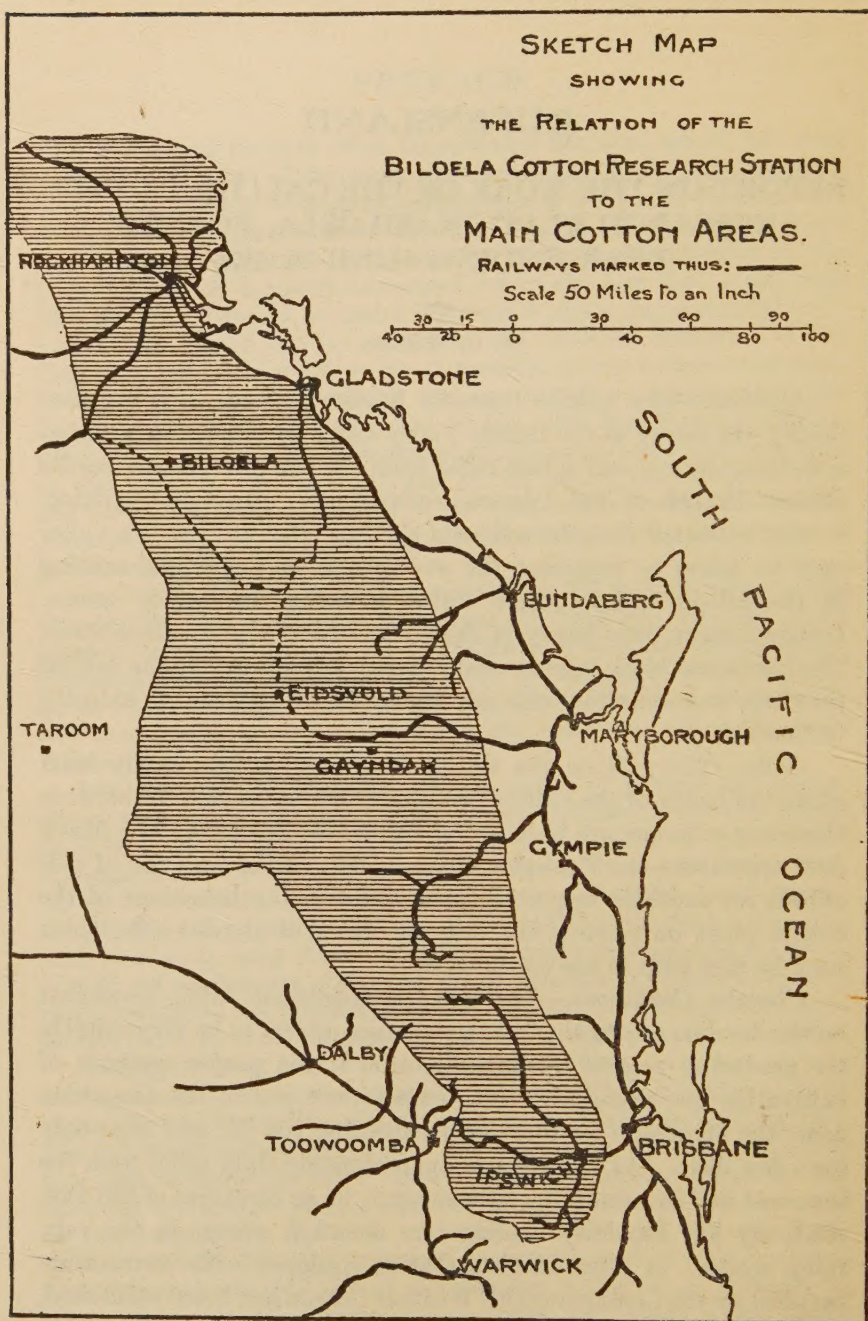
BY

W. G. WELLS.

Location.—The Callide Research Station is located in approximately the centre of the Callide Valley Land Settlement scheme, at a distance of one and a half miles from the town of Biloea, on the Rannes Branch of the Dawson Valley Line. Generally speaking, it may be stated that the soils and climatic conditions of this valley may be taken to represent the average of the conditions existing in the inland valleys where cotton is being successfully grown. Geographically, it is nearly in the centre of the largest cotton areas. The location is ideal, from several viewpoints, for studying the various problems in connection with establishing a cotton-growing industry in Queensland.

Soils.—The soils on the station vary from a light sandy loam along the banks of the Callide Creek to heavy box soils. In between these two extremes are to be found various loams ranging to a heavy dark type along the Washpool Creek. Such a wide variation of soils affords an excellent opportunity of studying the behaviour of the cotton plant on most of the different types of alluvial soils which may be met with in the cotton areas.

Climatic Conditions.—The climatic conditions, while somewhat on the dry side during the last two seasons, appear to be very suitable for producing a good quality of cotton if the proper methods of cultivation are exercised. The temperatures are of the temperate zone, the maximum reading rarely exceeding 100° F., and then only for a few days. As the valley is approximately sixty miles from the sea-coast and in behind the coastal range, at an elevation of 530 feet, relatively low humidity readings are recorded, except in the very rainy season. A climatological station equipped with instruments supplied by the Commonwealth Weather Bureau has been established, and daily readings are recorded of the air and soil temperatures, the relative humidity, and the amount of evaporation taking place.



Appropriations.—The funds for developing and running the station are supplied by the Empire Cotton Growing Corporation, the Commonwealth, and the Queensland State Governments. The grants from the first two organizations assist in meeting the annual recurring expenditures, while the development work is borne by the Queensland Government.

Staff.—The technical staff positions consist of the Manager, an Assistant Plant Breeder, an Assistant on general cotton problems, and an Assistant Entomologist. With the exception of the latter, who is instructed by the Commonwealth Cotton Entomologist, the staff is under the control of the Cotton Specialist employed by the Queensland Department of Agriculture.

Plan of the Station.—The area of the station consists of 417 acres, of which a major portion had standing dead, ring-barked trees at the commencement of the development operations. Approximately 135 acres have been brought under cultivation, which will be sufficient for the present for the investigations which are being carried out.

Seasonal Conditions.—The climatic conditions at the Callide Research Station this past season may be described as being somewhat unfavourable for producing high yields of good quality long-stapled cotton. Good rains fell during the months of May to August inclusive, a total of 6.47 inches being recorded. This enabled the old cultivation areas to be brought into a good state of tilth with fair moisture in the subsoils.

Light planting rains fell in September, which enabled only the cotton in the rotation series to be planted. Unfortunately, a dry period was experienced from then until the first part of November, when good rains fell which allowed the rest of the crops to be planted.

Rains fell at sufficiently frequent intervals from then until the end of December to develop a well-grown plant with deep-rooted tap-roots. By the middle of January the early planted plots gave promise of yielding the highest yields that the station had ever recorded. Unfortunately, at this period a very severe storm of 4.55 inches was experienced which fell in two hours, and was accompanied by heavy winds which blew over a considerable percentage of the crop. The force of the storm set the soil to such an extent that small benefit was derived, and owing to the height of the plants no cultivation could be effected to conserve the moisture which penetrated beneath the surface. In a surprisingly short time all plots required added moisture, which was received in the middle of February through a storm of similar nature, 4.57 inches falling in two and a

quarter hours. The hard surface, however, prevented much of this storm penetrating to the subsoils, so that only a partial recovery was made in most plots. From then on for the rest of the season a dry period accompanied by high temperatures was experienced.

In spite of such erratic and unfavourable weather conditions the yields on nearly all of the plots were good, and the quality of the cotton produced was of much higher standard than that of any previous crops of the station.

This may be explained by the fact that the soils have improved with cultivation, and that six and a half acres were sown with selected seed. It is anticipated that in the coming seasons the quality of the crops will show further improvement as the processes of improving the seed become more effective and the cultural practices more refined to suit the various soil requirements.

Considerably higher yields would have been obtained if the first killing frosts had occurred about the middle of June. A good top crop of large well-developed bolls was present in nearly all of the plots at the time that the plants were cut down and burned preparatory to the ploughing of the soil for the next season's seed bed. The bolls, while green, contained fully developed fibre, and only required a light killing frost to hasten their opening.

The advantages of early prepared seed beds are so pronounced in a country with so precarious a spring rainfall as has Queensland, that it is believed that more profit is obtained from the yield of the succeeding crop, where such methods have been practised, than by letting the old crop stay on until all the top bolls are harvested. A further point in favour of eradicating the crop by the end of June is that it increases the chances of more effectively destroying any pests which may be present towards the end of the season.

Operations under Review.—The results from the operations on the station for the past season have been somewhat varied in the degree of success which has been obtained. Generally speaking, it has been a successful year. The progress which has been made in the various lines of investigations, while not always of a clear-cut, definite nature, must be considered fairly satisfactory. The results contribute towards that accumulation of evidence which is necessary in dealing with problems in agricultural crops. Several of the lines of investigation require several years of repetition before any definite conclusions may be expected to be reached.

Cotton.—With some exceptions, the cotton plots gave very good yields, considering the climatic conditions, and demonstrated that cotton can be grown very successfully in the Callide Valley, provided

the proper cultural operations are practised. The yields from the various plots on the different types of soil indicated, as was the case last season, that considerable care should be exercised in selecting a suitable type of soil in this valley for growing cotton. It appears that a desirable type should be of a medium to heavy loam containing a slight mixture of clay and overlying a heavy subsoil. Such a combination not only affords a good moisture-carrying soil for the early development of the young cotton plant, but also holds the lower moisture up to the roots during excessive periods of heat or drought in the later stages when the plants may be heavily laden with fruit. Owing to the variable climatic conditions every endeavour should be made to follow the best methods of cultivation, such as early establishment of a well-prepared seed bed; planting on the first rains after the danger of late spring frosts has passed; the spacing of rows and plants so as to give a maximum amount of insurance against severe periods of drought, and still not lower the yields to an unprofitable basis; thinning at the stage which best assists in establishing the plant to resist climatic variations; and frequent cultivation during the growing season so as to conserve moisture and reduce weed and grass growth. These are the principles which are used in the growing of the bulk of the cotton crops on the station. Many of the experiments deal with the various problems bearing on these points, and it is hoped that sufficient accurately determined evidence may be obtained to assist in arriving at the proper method for each operation.

Fodder Crops.—It is realized that dairying is the basic industry for most of the areas where cotton is being grown. Accordingly a rotation series has been included in the station's activities in the endeavour to determine the most profitable of the customary fodder crops of the district which can be grown in combination with cotton. In conjunction with this experiment a test has been established in which various fodder crops and combinations of crops are tested out in an endeavour to determine which is the most valuable for use in the rotation series. As in the past seasons, a considerable acreage of wheat was grown during the winter to augment the supply of hay required by the working livestock on the station. A very fine quality of hay was made this season, and yields averaging 30 cwt. of dry hay per acre were obtained from most of the plots.

Maize.—No bulk plots of maize were grown this season owing to the large acreage of maize which was devoted to the maize trap experiments in connection with the Maize Grub or Corn Ear Worm (*Heliothis obsoleta*) investigations. The records of the yields were not kept, seeing that only a portion of the plots were left to mature grain.

Plantings were made on November 11, December 15 and 26, and January 14. The December 15 planting gave the best type of ears, and would probably have given the heaviest yield per acre. The results secured this season from the maize plots indicate that average yields of maize may be expected in this district. Soils of high moisture-carrying capacities should be selected, however, as the periods of high temperatures, accompanied by droughty conditions which frequently occur in this district, have a very detrimental effect on the quality of the crop, unless grown on such soils.

Green Manure Crops.—In an endeavour to build up some of the soils which are of a droughty nature, owing to a high percentage of very fine particles of clay being present, a considerable acreage of the black variety of cowpeas was grown for ploughing under this season. Unfortunately the very heavy storms in January and February seemed to set the soil in the rows to such an extent that, although inter-row cultivations were made after the rains, the plants were not able to produce much growth during the long drought which persisted for the rest of the growing period. This crop was ploughed under late in the season, and will be allowed to fallow all winter preparatory for another planting of cowpeas next season. In addition to this work the effect on cotton following a green manure crop, such as cowpeas or a nitrogenous crop such as peanuts, is being tested out in the rotation series.

Cotton Breeding.—Marked progress in this very important phase of the activities of the station has been made this season. A six-and-a-half-acre plot, sown with bulk-selected seed grown on the Monal Creek Demonstration area of last season, was grown on the newly cleared section of the farm, and yielded at the rate of 1,254 lbs. of seed cotton per acre. The seed obtained from these plots will be sufficient to plant the whole of the bulk and experimental plantings which will be made next season, and in addition any growers within half a mile of the stations will also be supplied with this seed in order to prevent cross-fertilization with the old stocks from taking place.

This block of six and a half acres of bulk-selected seed was carefully inspected plant by plant when the crop was mature, and 670 plants were selected as representing the B type of Durango plant (see Fig. 1). This type, which is of an erect, stiff habit of growth with fruiting branches of some four to six internodes in length, appears to be the most suited to the inland valley conditions, and all selections are confined to this type; 220 lbs. of seed cotton were obtained from these plants, the seed of which will be used in planting a five-acre plot on the station this coming season for further increase work.

It is appreciated that the system of building up a supply of seed by the method of "bulk selection" is but a quick way of obtaining a fairly uniform commercial lot of cotton. It is only by means of careful selection of the individual plant under the progeny row system that a strain uniform in all respects may be obtained. Accordingly several plants of a very desirable type were selected at the Monal Creek Demonstration Farm in the Upper Burnett, and on the Research Station last season. The best of these were planted on the Research Station this season, and several progenies have shown remarkable uniformity for the first year under test. Individual selections for further progeny study were made in the best rows, and the remaining plants of the row which gave the most promising results were picked in bulk separately from the rest. The seed from this row will be planted in an isolated plot this coming season for further study, and if investigations prove it to be desirable for increasing for general distribution, it will eventually supplant the bulk-selected cottons. A definite system of supplying seed of a uniform variety bred up to meet local requirements has thus been established, which should enable the growers in the Callide Valley and other portions of the Central Queensland district to produce an excellent class of cotton.

EXPERIMENTS.

Ridging Experiment.—In the endeavour to reduce the expense of hand eradication of weeds and grass, the general system of cultivation on the Research Station has been gradually to work the soil to the plants at each cultivation by means of the disc cultivators, so as to smother any young growth. Excellent yields have been obtained each season with such a method, but the question arose as to whether such a system was as conducive to conserving moisture as flat cultivation would be. It has been considered desirable to leave the plants well ridged up at the last cultivation in order to afford a brace for the well-laden plants against any storms which might occur during January and February. This would assist in preventing their being blown over sufficiently to "lodge," which is very undesirable, because it both increases the danger of boll rots and handicaps the pickers. The point that arose to be settled was whether this ridging could be done as well if left until the last cultivation.

Accordingly an experiment was designed which included the following features:

Five Rows.—To be cultivated flat until the last cultivation, when as heavy a ridge as the machine could put up without damaging the plants would be effected.

Five Rows.—To be cultivated flat all the season.

Five Rows.—To be gradually ridged with each cultivation.

Unfortunately, heavy rains occurred in January following good growing conditions in December, so that the Manager "barred" off the plot in order to prevent excessive growth. This procedure consists of reversing the discs on a disc cultivator and cutting away the soil around the plants, so as to leave a ridge of about 8 inches wide. This ridge is left exposed for a few days, according to the amount of sun and the height of the temperature, so as to dry out the soil somewhat, and then covered up again, so as to leave a high ridge of loose soil to give the proper mulch. This method of "barring-off" is a very efficient way to check the growth of rapidly growing plants if done at the proper stage, and gave excellent results at the Research Station in both this and last season's cotton crops. The main precaution to take is not to cut too deeply with the discs, as the operation is a soil-drying one rather than root pruning (see Fig. 2).

This "barring off" may have complicated the experiment somewhat, so that the results obtained may not be strictly representative of the effects of the different methods of cultivation. It is being conducted again this coming season. However, some differences were obtained, as the means of the rows under each treatment were as follows:

<i>Treatment.</i>	<i>Rate of Yield per Acre.</i>
1. Flat cultivated, until last cultivation, then ridged ..	950 lbs. seed cotton.
2. Flat cultivated throughout	1,011 " " "
3. Gradually ridged through whole period of cultivation	1,081 " " "

While the yields between the flat cultivated and the ridged throughout plots are not very different, there was a noticeable difference in the behaviour of the plants of the plots during the extremely hot dry period of the latter part of January. The ridged plants in Plot 3 remained much fresher throughout the day than did the plants in the other two plots. The explanation of this may be that the continuous ridging of loose soil around the plant gave a better mulch and assisted in conserving the moisture directly under the plants, even though there was a possibility that the ridge prevented the full effect of light storms penetrating to the subsoil immediately around the tap root.

Orientation of Rows Experiment.—In a country where cotton is subject to fungous diseases, and where heavy rains may fall during

the early part of the boll-opening period, it may be advantageous to give the plants plenty of light and circulation of air. In this connection the point has been raised as to whether any benefit is obtained by planting the rows in an east-west direction or a north-south one. An experiment along these lines was performed this season with the rows $4\frac{1}{2}$ feet apart and the plants spaced 2 feet apart. Unfortunately, in a very severe storm occurring in January the water backed up in a depression, and overflowed to such an extent as to submerge this experiment for some days. The plants on all but four of the plots were killed, and in some the soil was set so firmly that a very restricted plant growth was made. With the material available, careful observations were made of the presence of boll rots, but only three cases were noticed—two in the east-west plots, and one in the north-south plots. A light attack of the Corn Ear Worm (Maize Grub) was also experienced, but of about equal value in all plots. The period of ripening did not appear to be influenced to any extent—only a few bolls in the east-west plots opening earlier than in the other plots. The rate of yields secured from these plots was as follows:

Plot 1. North and south rows	..	..	1,434 lbs. of seed cotton per acre.
Plot 2. East and west rows	..	..	1,501 " " " "
Plot 3. North and south rows	..	..	1,424 $\frac{1}{2}$ " " " "
Plot 4. East and west rows	..	..	1,348 " " " "

The growth of the plants on a portion of Plot 4 was influenced by the water somewhat more than on the rest of the plots, so that no reliance can be placed on the results obtained from this plot. This experiment is being repeated in the coming season.

Paired Row Experiment.—The peculiar irregularities of the climatic conditions in the various parts of the cotton areas in Queensland make it a problem to select a spacing for the rows which shall be suitable to the variable conditions. The months of January and February may be very wet, as shown by records of former years. With the exception of 1924, they have been very dry and hot during the last four years. Another factor which complicates the problem is the time of planting, which may extend from early in September until the middle of November, according to the arrival of the spring rains. The experiences of growers and the results obtained on the Government Stations indicate that where an early stand is obtained much of the difficulty is overcome. The plants from the early sowings develop a stocky, well-laden structure with a good tap-root system. This controls the development of the plant in any periods favourable to vigorous growth, while the well-developed tap-root system assists the plant in withstanding the effects of periods of drought. It can

be seen that with such a plant the problem of the proper spacing is much simplified. On the average of the Queensland soils spacings of $4\frac{1}{2}$ feet between the rows and 20 to 24 inches between the plants give very good results, and are used by most of the growers as well as in the bulk plantings on the Research Station, where yields per acre of 1,000 to 1,200 lbs. of good quality seed-cotton are obtained. In seasons when early strikes of cotton cannot be secured, the spacing problem becomes more difficult. The latter half of October is usually dry, and ordinarily, if planting has not been carried out before this time, it becomes necessary to wait for the November storms. November-planted cotton has a tendency to make a somewhat vigorous growth, and unless checked by short periods of dry conditions during early January, enters the period when heavy rains may be experienced in a very unsatisfactory stage. This is also the time of the heaviest incidence of the Corn Ear Worm (*Heliothis obsoleta*), and if a severe attack is experienced, the resultant loss of squares makes it all the more difficult to control the growth of the plant during luxuriant growing conditions. The crop of 1923-24 experienced such conditions, the general plantings not taking place until November. A heavy Corn Ear Worm attack occurred in January, followed by severe storms in February. The result was that nearly all crops on fertile alluvial soils were failures, the plants growing to 6 to 7 feet high with only a scattering top crop of bolls, which did not mature. Experiments in controlling the growth of irrigated cotton on heavy soils, by the United States Department of Agriculture, have indicated that some control may be effected by spacing the rows in pairs with sufficient distance between the pairs to give an "outside row" effect. In most cotton fields the outside rows are usually the most heavily laden, and especially in fields of rank growth. An experiment based on this principle has been conducted on the Research Station this season, the following spacings being included:

Single spacing of rows $5\frac{1}{2}$ feet apart.

Pairs $4\frac{1}{2}$ feet between the two rows— $6\frac{1}{2}$ feet between the pairs.

Single spacing of rows $4\frac{1}{2}$ feet apart.

Pairs $4\frac{1}{2}$ feet between the two rows— $5\frac{1}{2}$ feet between the pairs.

Single spacing of rows—5 feet apart.

No significant differences between the yields were obtained. Owing to the newness of the station unexpected irregularities in the soil conditions are often experienced, and unfortunately the experiment was affected in this manner this past season. From notes

taken on the development of the plants, it appeared that the wider single spacings, especially the 5½-feet spacing, were much more inclined to vegetative growth. Counts of plants in each treatment showed the following data regarding the number of vegetative branches per plant:

5½-feet spacing	..	..	..	..	4.45 branches per plant	p.e. ±0.103
5½-feet pairs..	..	..	..	..	4.03 " "	.. ±0.078
4½-feet spacing	..	..	..	..	3.8 " "	.. ±0.076
5½-feet pairs..	..	..	..	..	3.6 " "	.. ±0.069
5-feet spacing	..	..	..	..	3.7 " "	.. ±0.077

The experiment is being repeated this coming season. It is believed that by pairing the rows the competition between the two rows of the pair may assist in restricting the growth, while the wide spacing between the pairs and also the tendency of the plants to spread outwards during the later stages of development may reduce the amount of shade and humidity around the lower crop to such an extent as to prevent loss from boll rots during excessive wet seasons.

Height of Thinning Experiment.—The effect of the height of the cotton plants at the time of thinning is believed to be of the utmost importance in Queensland. The average cotton grower does practically all of the work in the crop. This is in addition to his regular farm duties, so that it can be seen that there is a likelihood of some of the work being somewhat delayed. This is particularly true of the thinning operation. Unless one is accustomed to "chopping" cotton, an acre a day is a fair performance, especially if a portion of the day is necessary for dairying, etc. A grower with a plot of ten acres of cotton is likely to be at least ten days in thinning it and generally more. If the growing conditions at that stage are favourable to luxuriant growth, the last plants to be thinned may be considerably taller than were the first plants when the operation was commenced. An experiment to demonstrate the effect of the thinning at the different heights, and also the effect of spacing, was designed for distribution among the farmers. This experiment was also conducted on the Research Farm this season. Briefly it consisted of thinning plants to distances of 15 and 24 inches apart when they were at the following heights: 4 to 6 inches, 8 to 10 inches, and 16 to 18 inches. The first two stages represent the different heights at which the average commercial ten-acre plot is thinned, but occasionally greatly delayed thinning is met with, so the 16 to 18 inches stage was included to demonstrate what the comparative effect would be when the plants were thinned at that height. Unfortunately, a slightly irregular strike was secured in this experiment which did not allow for the uniform proper spacing in all the rows. The results are

included, however, as they indicate a tendency for heavier yields to be obtained from the plants thinned earlier. General observations over the last four seasons in Queensland indicate similar conclusions. From the material obtained it appears that if the farmer starts to thin when the plants are 4 to 6 inches high, and completes this operation by the time they are 10 to 12 inches high, there will be a small loss of yield experienced on the portion of the field which was thinned last, other factors being equal. Owing to the slight irregularity of spacing no definite conclusions could be drawn from the spacing feature of the experiment. The whole experiment will be repeated in the following season, as several seasons of carefully conducted experiments are required before any definite conclusions can be drawn. It is possible that when such material is available, it will be shown that the thinning should be hastened so as to complete this operation before the plants are over 8 inches in height. The yields are as follows:

MEAN YIELD OF 100-FOOT ROWS IN LBS. OF SEED COTTON.

										<i>Rate per Acre.</i>
24-inch spacing, thinned when	4 to	6 inches tall	..	mean	11.8	p.e.	±0.42			1,142
24-inch	"	"	"	10 to 12	"	"	±0.60			1,006
24-inch	"	"	"	16 to 18	"	"	±0.56			958
15-inch	"	"	"	4 to 6	"	"	±0.68			1,084
15-inch	"	"	"	10 to 12	"	"	±0.28			979
15-inch	"	"	"	16 to 18	"	"	±0.33			977

In order to determine the effect that the different spacings and thinnings had on the size of the bolls, fifty four-lock bolls were collected from each treatment, one boll per plant. The following table gives the mean weights per boll, and the probable error of the result:

Thinned 6 inches high to 15-inch spacing	..	mean weight	6.17	grams	p.e.	±0.08
" 6	"	24-inch	"	"	"	±0.17
" 12	"	15-inch	"	"	"	±0.13
" 12	"	24-inch	"	"	"	±0.11
" 18	"	15-inch	"	"	"	±0.08
" 18	"	24-inch	"	"	"	±0.13

It will be noted that with the exception of the 15-inch spacing at 18 inches high there is a decided tendency for the weight of the bolls to increase as the height of the thinning is delayed. This may be explained by an examination of the yields of the plots which show a tendency to increased yields in the early thinned rows. It would appear that the early thinned plots gave a greater number of bolls per plant, but under the droughty conditions which existed a certain reduction in the size of the bolls resulted. This did not lower the yield per row, however, to less than that of the other spacings, and

under more favourable climatic conditions it is probable that much higher yields would have been obtained from the earlier thinned plants owing to an increased weight of the bolls.

Insect Control.—Generally speaking, with the exception of the Corn Ear Worm (*Heliothis obsoleta*), the season under review at Biloela was remarkably free from insect attack. This may be accounted for by the severe heat waves and drought which occurred at this station during January and February. Such climatic conditions must have checked the population of *Dysdercus*, *Tectacoris lineola*, and *Oxycarenus* to a marked extent, as was shown by the very high grade of cotton which was received from the whole of the Callide Valley.

When cooler weather, accompanied by light showers and dews, was experienced, these insects increased in numbers to more normal proportions at the end of the season. The whole of the farm's crop was cut when in a green condition, and stacked for burning. *Dysdercus* in particular likes such resting places at this period of the year, so that it is believed that burning the crop under such a system greatly reduces the population for the winter carry-over. The incidence of *Tectacoris lineola** and *Dysdercus* is closely associated with the occurrence of the internal boll rots, and the accompanying low grades of cotton. Methods which assist in controlling them, therefore, are of the utmost importance. The cutting and burning of the plants before all of the top crop of late bolls is matured also materially assists in checking the occurrence of the Pink Boll Worm (*Platyedra gossypiella*), the Peach Grub (*Conogethes punctiferalis*), and the Rough Boll Worm (*Earias hugelli*).

Maize Traps.—The use of maize plantings to control the attacks of the Corn Ear Worm (*Heliothis obsoleta*) was carefully investigated on a large scale at the station this season. The observations and experiments of the Commonwealth Cotton Entomologist, during the preceding crop, gave evidence which indicated that this pest might be controlled by the planting of plots of maize at intervals which would provide continuous green maize plants to attract the moth of this insect. The first two crops of maize should be cut when in full silk, as this is the period when the largest number of grubs are present. If allowed to remain uncut, the grubs pass into the surface soil, where they pupate preparatory to emerging as moths for laying eggs of another generation of grubs. Accordingly all of the cotton plots, with the exception of the early planted cotton in the rotation

* "The Life History of *Tectacoris lineola* and its Connection with Internal Boll Rots in Queensland," by E. Ballard and F. G. Holdaway, *Bulletin of Entomological Research*, vol. xvi., part IV., 1926.

series, were planned so as to allow for a border of maize for every four borders of cotton. This works out at the rate of fifteen rows of maize for every sixty rows of cotton. The cotton plots included in the experiment were planted from November 5 to 9 inclusive. Four rows of maize were planted November 11, the second four December 15, and the third planting January 14. The results secured from the experiment were very striking. In the Monal Creek bulk planting which was included in the test the average yield per acre was 1,254 lbs. of good quality cotton. In addition, a heavy top crop of green bolls which needed but a light frost to open them was destroyed when the plants were cut preparatory to ploughing for the following season's crop. In the H group on a three-acre plot, where the second planting of maize was delayed from December 15 to 26, a very heavy attack of the maize grub was experienced. The effect was so severe that the lower crop of bolls was practically a failure with the exception of one end where the soil was of heavy moisture-retaining properties which forced a greater rate of production of squares. In addition to this factor, the borders of cotton were only separated by a narrow roadway from the maize traps of the adjoining plots, in which the rows of maize of the second planting had been sown on December 15. It is reasonable to believe that this maize would attract a certain number of the moths occurring in the H group, and thus lessen the degree of attack experienced in this plot. The loss of the lower crop over the major portion of the H group resulted in a rank vegetative growth occurring, accompanied by shedding. This was followed by heat waves checking the growth and causing further shedding. The final result was practically no fruit on this plot with the exception of the portion on the heavier moisture-retaining soils.

It appears that the maize trap offers a solution to the problem of Corn Ear Worm attack on late-planted cotton. The results obtained on the station and by farmers in nearly all districts indicate that early planted cotton generally escapes serious injury from this pest. It may not be possible to effect early planting in every season. The usual result obtained from late planted cotton—*i.e.*, late October on through November—is a considerable loss from the attacks of Corn Ear Worm; therefore, it is advisable for the grower to utilize any methods which assist him in protecting his crop. It is realized that in some cases it may not be possible to plant the maize at the proper intervals. Accordingly during the coming season experiments in the use of calcium arsenate will be conducted. For this purpose a three-row dusting machine of the latest pattern has been imported from the U.S.A.



FIG. 1.—THE B TYPE OF THE DURANGO VARIETY.

This is the standard type for the cotton breeding operations at the Callide Cotton Research Farm. (Leaves picked off to show fruiting habit to better advantage.)



FIG. 2.—ILLUSTRATING THE PROCESS OF "BARRING-OFF."

SOUTH AFRICA

REPORT ON THE WORK OF THE COTTON-BREEDING STATION, BARBERTON, AND OF THE EXPERIMENT STATION, CANDOVER ESTATES, NATAL, FOR THE SEASON 1925-26

INTRODUCTORY NOTE BY MR. S. MILLIGAN.

IN forwarding the Annual Reports of the Cotton-Breeding Station at Barberton and of the cotton experiments in the Candover area, I wish to add the following remarks.

The necessity for an intensive study of the cotton-growing problems of the Union of South Africa, in view of the rapid expansion of the area under the crop, was fully recognized by Government when the assistance of the Empire Cotton Growing Corporation was enlisted for this purpose at the time of the last Imperial Conference. The subsequent decline in cotton prices has rendered a solution of some of the more pressing of these problems all the more urgent; a concentrated effort towards a general improvement in yield and towards a greater security of the crop in unfavourable seasons is urgently required.

The assistance of the Corporation dates from the season 1924-25. It was decided at the outset that the two most urgent questions in which the Corporation could help were: (1) The breeding of varieties suited to local conditions; and (2) a further study of cotton pests with a view to finding preventive and remedial measures. It was also considered desirable that the question of phosphatic manuring for the cotton crop should receive further attention, there being a general want of knowledge as to the economic application of this fertilizer in the widely varying conditions of soil and climate in the cotton-growing tracts of the Union.

With reference to the plant-breeding work, it was decided that two main tracts should be recognized, the middle and low veld areas, and that as the former was already well catered for by the Rustenburg Tobacco and Cotton Station, work for the latter should be undertaken by the Corporation through a headquarters station at Barberton.

To assist in a more intensive study of the cotton insect pests two whole-time men were recruited and placed in the Division of Entomology.

A somewhat similar arrangement was made with the Division of Chemistry whereby the Corporation pay the salary of a junior supernumerary in order to permit of a senior officer taking charge of a comprehensive series of field experiments with phosphatic fertilizers distributed over a wide area under varying conditions of soil and climate.

In 1925 it became apparent that the intensive growing of cotton in some of the low veld areas presented special problems which demanded attention. An offer from the Candover Estates to supply the necessary land and buildings for a special officer for this work was finally agreed to by Government and the Corporation, the latter supplying the man, the former his travelling expenses.

I have thus two reports to submit, one from Mr. Parnell, being a record of the year's work at the Barberton Cotton-Breeding Station, the other from Mr. Parsons, dealing with his work in the Candover area. Both officers have received much assistance from the cotton-growers in their respective districts in many directions. Our special thanks are due to the Barberton Municipality for the excellent site for the cotton-breeding station provided at a nominal rent from the town lands. The ready co-operation of the officials of the Department of Agriculture has, to no small extent, facilitated the work.

BARBERTON COTTON-BREEDING STATION.

As mentioned above, the work of the breeding of cotton to suit low veld conditions has been entrusted to the Corporation. The work was started by Mr. Parnell at Barberton in the season 1924-25 on a plot of land kindly lent for the purpose by the Jail Department. The plot, although too small for a permanent site, enabled Mr. Parnell to make a preliminary examination of the several varieties of cotton grown in the Union, and of a number imported from America and India.

The chief feature of the season was the severe attack of Jassid and the enormous damage caused by this insect both in the experimental plots and throughout the low veld generally, indicating the importance of Jassid-resisting types for the low veld. It was apparent that not only could the pest do a great deal of damage to the main crop, but that it was quite capable of inhibiting the formation of a useful top crop, the main insurance of low veld cotton in unfavourable seasons. The attack also proved of great value in enabling the resisting qualities of the local and imported varieties to be compared and estimated, the general conclusion being that

none of the local varieties, as they stand at present, are sufficiently resistant to withstand a severe attack of Jassid, and of the imported varieties, Cambodia alone could be considered satisfactory in that respect. The latter, however, although it was practically immune to attack, in the changed conditions showed up as a most undesirable type, being not only short-linted, but also of an exceptionally loose and tall habit, while in addition it was late in maturing. A search among the local varieties in the veld disclosed the existence of single plants showing resistance to Jassid, and although it was no easy matter to find this quality combined with length of lint and high yield, a considerable number were eventually obtained. From these, and from selections from a few single-plant lots obtained at the end of the preceding season, Mr. Parnell obtained the greater part of his material for the past year's work.

The establishment of the new Cotton-Breeding Station on a site given by the Barberton Municipality enabled work to be started on a much more extensive scale in 1925. A heavy infestation of Jassid again facilitated work, all the new strains being thoroughly tested as regards resistance. The previous year's experience with regard to the susceptibility of the Union and of the imported varieties was confirmed, Cambodia again being the only one of the two groups to show resistance. The single-plant selections, on the other hand, did remarkably well, nearly all showing a marked improvement on the parent varieties, the best being very good indeed as regards both Jassid resistance and other desirable qualities. Thirty of the lines from Improved Bancroft and six from Zululand Hybrid are being carried on for future work, while bulk seed of ten of the most promising of the former, along with the whole of the latter, is being retained for testing and provisional multiplication. The progress towards seed of pure Jassid-resisting strains in bulk is thus highly satisfactory; no time will have been lost during the testing period in the event of one or more of these turning out satisfactory on a field scale.

The position with regard to quality of lint has turned out better than could have been reasonably hoped for at the outset; it now seems certain that there will be no loss in quality through growing Jassid-resisters.

The behaviour of Cambodia is interesting. Ten selections had been made in the previous year from the variety which had been newly imported from India. In each case these, when grown in this season, showed remarkable increase over the parents in length of lint, while retaining the resistant character. One of the selections has shown signs of splitting for habit into tall and short plants, the

latter carrying all the more desirable characters—*e.g.*, yield, earliness, and good lint. The last, apparently, has not been heard of Cambodia. If, as Mr. Parnell says, a pure strain carrying these characters can be fixed, it would be of immediate economic value.

From the point of view of the breeding work, a study of several aspects of the Jassid pest is of great importance. A great deal of useful information was obtained during the year, both in the field and in the laboratory, more especially with regard to the occurrence of the pest, the nature of its attack, and the relation of leaf characters to susceptibility. These are all clearly described in Mr. Parnell's report.

The cage experiments were characterized by their extraordinary definiteness—nothing more definite could well have been imagined—they had to be seen to be appreciated fully. This remark also applies to the breeding plots, the contrast between the parent varieties and the new resistant strains being so marked as to be observable at a long distance from the field.

Seed for Distribution.—In view of the time taken to produce pure strains, and to multiply these up to a field scale, consideration was given in the previous season to the possibility of effecting by mass selection some temporary improvement, however slight, in the seed supply for the low veld. An examination of the existing varieties, however, showed an absence of sufficiently defined types; later on, the appearance of Jassid and its disastrous effects confirmed the uselessness of proceeding along these lines. As an alternative, it was decided to retain the bulk seed, after selections had been made, from Z1, an outstanding plant lot, and, if this continued to show sufficient improvement on the local varieties, to issue the seed as a forerunner to a pure Jassid-resistant strain. The $4\frac{1}{2}$ lbs. of seed available from last year's plants have, by careful multiplication, been increased to 650 lbs. after fully 50 per cent. of the plants had been rejected. This will be remultiplied over several hundred acres in the coming season, and if it continues to do well, the seed will be distributed to cotton-growers, to be followed up by one of the single-plant lots.

CANDOVER EXPERIMENT STATION.

As stated above, intensive cotton-growing in the low veld gives rise to special problems which are likely to assume considerable importance in the future; indeed, some of these are already beginning to make their appearance. One of the chief advantages of the Candover area as a centre for investigation lies in the great wealth of material for an enquiry; the investigator has at hand a wide variety

of soil and climatic conditions, coupled with great variation in times of planting, dates of ploughing, and other agricultural operations.

Mr. F. S. Parsons, a former Corporation Studentship holder, was selected for the post, and joined his appointment in September, 1925.

It was decided that, in order to retain flexibility, lines of work should not be laid down in too much detail, and that at the outset a study should be made of local practices, more especially with regard to their bearing on diseases and insect pests and crop yields. The local control of the phosphate experiments in the Candover area was placed in the hands of Mr. Parsons, also the testing out and multiplication of new varieties and strains for the area.

It was necessary to have a headquarters block of land for plot experiments and observation work. This was supplied by the Candover Estates; the site chosen, however, did not prove satisfactory, and a new piece of land has had to be selected on another part of the estates for the coming season's work. As will be seen from the report, the plot experiments have to a large extent been spoiled by the severe drought which prevailed in the area throughout the entire season; the little rain which fell was very partial in its incidence, and the plots for the most part happened to be in the places that fared worst.

The season was not, however, without its usefulness; it demonstrated in no uncertain manner the great advantage of early ploughing and preparation in dry years, a point which will not be lost sight of in the district. It also allowed Mr. Parsons to devote a large amount of time to general observations, especially on insect pests, and to design his experimental work for the coming season. Amongst other useful pieces of work may be mentioned the preliminary list of wild food plants of the spiny bollworms, the discovery of what may be a wild host plant of the red bollworm, and the observations on the occurrence of bollworm on stand-over cotton.

The system referred to in the report of utilizing stand-over and ratoon cotton as a trap-crop for early bollworms promises to be of great interest. The possibilities of this method were suggested by Mr. King, the Corporation's entomologist in Nyasaland, while on a visit to the Union in 1924. Observations made last season showed the possibility of destroying large numbers of larvæ and eggs by cutting down ratoon crops at the critical moment. Whether any method employed would result in an appreciable reduction of the bollworm population later on in the season remains to be seen. But the question is well worth careful investigation, and Mr. Parsons's attempt to systematize cuttings so as to obtain maximum results from the traps appears to be on the right lines.

COTTON-BREEDING STATION, BARBERTON— REPORT FOR SEASON 1925-26

BY

F. R. PARNELL.

INTRODUCTION.

Station.—The new cotton-breeding station, mentioned in my last report, was opened in time for this season. The help very kindly given by the De Kaap Agricultural Society, especially Messrs. Andrews, Spear and Gass, in clearing and ploughing an area of land in April and May, contributed very largely to the success of the season's work. Heavy rains in September, when work was started officially on the station, made it possible to get the land into better order than was anticipated. It was still very rough for experimental work, but not so irregular as might have been expected.

It has been rather a struggle to carry out a full season's work on a station in the making, and lacking many of the simplest facilities. There is still no water-supply or accommodation for the foreman, though these are being provided.

Season.—The season has been abnormally hot and dry for this district, though on farms where the rains have been well distributed this has suited the crop very much better than the cold, wet season of last year. It will be seen from the rainfall record appended that a total of about 24 inches was received during the season, from September to April, and a further 2 inches in May, but the distribution was irregular. On old cultivated land this would have been reasonably good, but it was decidedly short for the newly-broken land of the station. The soil is a slightly heavy loam, and the presence in this of a large amount of undecomposed grass roots and other organic matter meant that only the heaviest showers penetrated. A number of showers of just under $\frac{1}{2}$ inch merely moistened the surface soil.

Planting was started on October 19, in good conditions after the heavy early rains, and continued for a month, during which time all the single-plant selections were put in. It was then very dry, and operations had to be suspended for a month till a good shower was received on December 17. The few lots planted after this date made relatively poor growth, and it was unfortunate that they included the collection of varieties and a variety experiment. The

latter was abandoned and the plants hoed out long before the end of the season, as there was obviously no hope of getting useful results.

The main crop germinated well, but was checked severely by the six weeks of dry weather in November and December. After this there was no really serious check, but the growth made was irregular as the plants suffered frequently from lack of moisture. Taking the season as a whole, the conditions were severe and the hardiness of the selections was well tested. In the absence of strong, vigorous growth Jassid found ideal conditions and developed a most virulent attack, again testing the selections severely.

SELECTIONS.

The selection work of the previous season was continued, special attention again being paid to Jassid-resistance. A total of 183 single-plant selections were put in, comprising 41 second-year and 142 first-year lots. The standard size of progeny row was four rows of 51 plants each, but in certain cases more rows, up to twelve, were given to specially good parents. One to three seeds to a hill were planted, according to the amount of seed available, at an inter-row spacing of $3\frac{1}{2}$ by 2 feet in the row, and a handful of kraal manure was dropped on the top. The kraal manure appeared to be effective in preventing the formation of a crust, though the conditions were not such as to test the method thoroughly.

It was feared that Jassid might not be prevalent enough to test the selections, or that it might be irregularly distributed over the area. In order to obtain some information on this point two rows of Watts' Long Staple, a specially susceptible variety, were planted at regular intervals throughout the area. In addition, the parent variety of each batch of new selections was similarly planted as a comparison. It may be stated at once that every plant of Watts' Long Staple was definitely attacked in February, and almost killed by the middle of March, having produced practically no good bolls. All the parent varieties followed suit, at slightly later dates, but they were less uniformly bad, and occasional plants survived and produced a few bolls. The selections covered a wide range in their degrees of resistance, but, taken as a whole, they were very much less damaged than their parent varieties.

Observations were made on all the material at intervals throughout the season, especially in connection with the visible effect of Jassid, but it was found impossible to keep growth measurements

or flowering records. Early in the flowering season about ninety of the best-looking and uniform lots, especially such as were markedly hairy, were noted, and six to twelve good average plants in each were marked for selfing.

Second-Year Selections.—In the previous season a number of re-selections had been made from Z.1, an outstanding single-plant lot, and also from several of the next best lots. Of the latter none showed sufficient resistance to Jassid to be worth keeping, and all were discarded. The Z.1 selections proved most interesting. An examination shortly before flowering showed them to be reasonably uniform throughout except with regard to hairiness. Of the twenty-four lots there were eight uniformly very hairy, five uniformly less hairy, and eleven very variable. Their behaviour to Jassid afforded an excellent illustration of the connection between hairiness and Jassid-resistance. Later in the season, when Jassid became bad, the eight very hairy lots were uniformly very resistant, the five less hairy lots were uniform for various degrees of susceptibility, and the variable lots were mixed for Jassid-resistance.

Hairiness is a difficult character to judge, and it was not possible to analyze the lots in detail. A few counts of the hairs on the under-side of the leaf, to which reference will be made later, showed 4.2 and 3.8 hairs per square mm. for two of the very hairy lots, and 1.8 for a less hairy lot, the latter having also definitely shorter hairs.

The resistant lots were by no means free from Jassid, but they showed only traces of the effect when the Watts' Long Staple was already nearly dead, and only slight damage by the time the Bancroft standard was practically gone. They remained substantially green throughout the attack, continued growth, and retained the bulk of their leaf till the end. Figs. 1 and 2 show typical plants of Z.1.9 and Watts' Long Staple towards the end of April. They were grown side by side under similar conditions. The Z.1 was leafy and green, whereas the few leaves remaining on the Watts were red and brown. The latter also shows the immature bolls dry and splitting.

Four lots with a fair stand at 2 feet spacing, about $\frac{1}{4}$ acre, yielded at the rate of 725 lbs. of seed-cotton to the acre, a good yield for the stand and the conditions.

There was not much to choose between the lots in the field, and an analysis of their chief characters showed fair uniformity inside the lots and also between the different lots. Certain figures for six of the lots are given on p. 27, in comparison with similar figures for the original Z.1 selection of the previous season.

Selfed seed was obtained from the above plants for carrying on the lines, and 20 to 30 lbs. of bulk seed from each lot for multiplication and testing. Spinning tests of the lint from several of the lots are being obtained as an additional guide.

<i>Strain.</i>	<i>Plants.</i>	<i>Lint Length (Mm.).</i>		<i>Ginning (per Cent.).—</i>		<i>Weight of 100 Seeds (Gms.).</i>	
		<i>Mean.</i>	<i>S.D.†</i>	<i>Mean.</i>	<i>S.D.†</i>	<i>Mean.</i>	<i>S.D.†</i>
Z.1. 5	12	29.4	0.64	29.8	0.50	12.4	0.55
Z.1. 9	13	28.7	0.72	30.6	0.84	12.3	0.52
Z.1. 14	13	28.5	0.75	31.4	0.76	12.2	0.39
Z.1. 15	12	28.8	0.72	32.2	1.03	11.6	0.80
Z.1. 22	12	29.1	0.76	31.5	0.92	12.1	0.74
Z.1. 25	12	28.9	1.02	31.1	0.70	11.7	0.47
All lots together..	74	28.8*	0.83	31.1	1.10	12.1	0.71
Z.1. parent ..	25	29.0	0.83	31.2	0.94	11.8	0.58

A spinning test of the original Z.1 selection showed it to be slightly longer, definitely stronger, and generally of rather better quality than the Improved Bancroft grown locally. In view of the apparent uniformity of the selection and its resistance to Jassid, the bulk seed was planted as far as it would go for immediate multiplication. About $4\frac{1}{2}$ lbs. of seed was planted singly by hand on just over 4 acres, at $3\frac{1}{2}$ by 3 feet spacing, and gave a stand of slightly less than 50 per cent. The crop showed the mixture for Jassid-resistance that would be expected from the behaviour of the single-plant lots described above. In view, however, of the very urgent demand for seed of any resistant strain, this bulk material was not discarded, but was rogued very severely at various stages throughout the Jassid season. Only decidedly resistant plants were retained, and well over half of the plants were removed. Over 650 lbs. of seed was obtained, and this will be multiplied by arrangement with various growers and tested in different localities in the coming season. If it does well, it will be distributed as a forerunner of a pure resistant strain from one of the single-plant lots.

First-Year Selections.—Reference was made in my last report to the selection of the parents of these lots. Of the selections eventually planted there were sixty-nine from Improved Bancroft, forty-three

* N.B.— $1\frac{1}{8}$ inches = 28.6 mm.

† Standard Deviations of single plants in all cases.

from Zululand Hybrid, and a few from Uganda. A few lots from Cambodia and Webber 49 were also planted, but these will be considered separately.

As already stated, Jassid was extremely bad, and the selections were subjected to a very searching test. Taken as a whole, they were much less affected by Jassid than their parent varieties, and it was easy to pick out the latter, even from a distance, by their red and leafless condition, as compared with the greener selections.

The different lots showed considerable variation in their degrees of Jassid-resistance, but only one or two of the worst showed no improvement on their varieties. A number of the best selections showed about the same resistance as the good Z.1 lots described earlier. They reached their worst condition about the middle of April, when they showed only moderate damage and were substantially green and still growing. After this date they improved somewhat in condition as the Jassid appeared to breed less rapidly. Of the parent varieties Bancroft and Zululand Hybrid reached the moderate damage stage six weeks earlier—*i.e.*, early in March—and were defoliated and practically dying by the end of March; Uganda followed slightly later, and was finished early in April. All three varieties gave a negligible crop consisting of one small early picking from the few bolls that were well grown before Jassid stopped further development. The bulk of the selections gave a fair crop, and ten good lots from which bulk seed was taken, together covering one-third of an acre, gave an average of 600 lbs. of seed-cotton per acre with a poor stand and 2 feet spacing.

The accompanying photographs (Figs. 3 and 4), taken towards the end of April, show a plot of the local Improved Bancroft compared with one of the good selections. They were grown near together under similar conditions.

In making the original selections, it was found that heavy-yielding resistant plants in a mixed crop tended to be short in staple, and it took some time to find good plants with lint of 30 mm., about $1\frac{3}{16}$ inches or over. This length was adopted to some extent as a minimum, and any plant with shorter lint was rejected unless specially desirable for other reasons. At the same time a few heavy yielding and good resistant plants with shorter lint, 25 mm. (about 1 inch) and upwards, were taken in view of the possibility that they might be more likely to come true to type, and give, eventually, the most useful economic strains. It was found, however, that types with fairly long lint gave just as good results as the shorter ones, from the point of view of Jassid-resistance and yield. In a few cases

parents were selected for specially long lint, in spite of only moderate resistance; these gave rise to poor lots, and have been discarded.

Thirty good lots have been retained for further work, a number of single plants, mostly selfed, being taken from each. Bulk seed has been taken from the ten best and most uniform of these lots for provisional multiplication and further observation. The three shortest lots have a staple of 29 mm., and the majority are 31 to 33 mm. (roughly $1\frac{1}{4}$ inches). Various types of habit are included, but the predominant types are small to moderate in size, compact, and free fruiting. Taken as a whole, the Bancroft selections have yielded the best types and most promising lots. The best all-round lot gave the following figures: lint, 30.7 mm., or $1\frac{3}{8}$ inches; ginning, 31.3 per cent.; boll weight, 7.5 gms.; weight of 100 seeds, 14.7 gms.; average yield of forty-two selected plants, 145 gms. This lot gives promise of being a decided improvement on the Z.1 selections.

It may be noted that, as in the case of the Z.1 lots, there was a definite connection between hairiness and Jassid-resistance. An examination early in the season showed considerable variation in hairiness, and all lots noted as less hairy or definitely mixed showed, respectively, less resistance or decided variation in resistance when Jassid became bad. Occasional lots, however, that were classified as very hairy showed poor resistance. The classification was very rough and purely by eye judgment, both stems and leaves being taken into account.

The few selections from Webber 49, made for Jassid-resistance in the previous season, proved disappointing. They were better than the bulk variety, but none was quite good enough to be retained. The best was no better in habit and staple than the good Bancroft selections, and it was decidedly less resistant.

Cambodia Selections.—The Cambodia grown in the previous season, No. 295 from Coimbatore, was uniformly very large, lax, and open, very late, and gave a staple ranging from 25 to 28 mm. with an average of 26.7 mm., just under $1\frac{1}{8}$ inches. Ten single plants were selected with lint lengths of 27 or 28 mm. With one exception these lots reproduced the same type of plant as before, though slightly less exuberant in growth as a result of the drier season. The staple, however, showed a remarkable improvement; there was practically nothing of less than 30 mm., and the average was about 31 mm. (over $1\frac{3}{8}$ inches).

The exceptional selection, of which half was grown from selfed seed, showed a definite indication of splitting for habit. The plants appeared to fall roughly into two groups: one lot being tall, lax and

late as the other Cambodias, the other group being decidedly shorter, less lax, and much earlier. The groups were not absolutely distinct, and the plants had been broken about badly by wind, hence it was impossible to separate and count them. The general appearance, however, suggested that the short plants might be simple recessives coming out. The short plants, from a general examination, possessed a slightly smoother and longer lint. A large number of plants of the short type have been taken in the hope that some will come true to the same type next season. They average 30.9 mm. (over $1\frac{3}{8}$ inches) in length, with a ginning percentage of 33.9. They yielded extraordinarily well, and if a pure strain of this type can be produced, it will be of immediate economic importance, though still an ugly, coarse type of plant.

The all-round improvement in staple was noticed in the bulk as well as in the selections, and was presumably due to the change of conditions in bringing the strain to South Africa. It is hoped that this improvement will be permanent. The occurrence of the splitting in one selection may be due to the same change in conditions, in that the strain, though apparently pure at Coimbatore, may contain plants heterozygous for characters that cannot develop in those conditions. A good many shorter plants also appeared in the bulk Cambodia, but some of these may have been crosses. Such breaking up of an apparently pure strain often follows a big change in the conditions, thus necessitating re-selection in a new country.

Three new strains of Cambodia were received from Coimbatore and planted on small plots. They were all less rampant than the original No. 295. The earliest and smallest, No. 664, gave a moderate yield of 30 mm. lint with a ginning percentage of 35. The next in size and earliness, No. 516, gave a good yield with a ginning percentage of 41, but a length of only 24 mm. The third strain, No. 440, was very late indeed and did not begin to open its bolls till late in July, more than a month after the normal picking was finished. The two former strains will be tried again in the coming season.

All the Cambodias have again proved practically immune to Jassid. This season, however, it was possible to find very occasional nymphs on the leaves, presumably bred there, though no damage could be detected.

VARIETIES.

Unfortunately the collection of varieties was planted late, after the middle of December, owing to a drought during the preceding six weeks. They all started well, but in the latter half of January

Jassid made its appearance and began to damage the young plants. Early in February some of the varieties were badly infested, whilst they were still quite small, and from then onward differences became more and more noticeable.

All the varieties recently introduced from America—viz., Delfos, Acala, Express, Mebane, Rowden, Lone Star, Cleveland, Belton, and Webber 49, together with Durango from Australia and the local Watts' Long Staple—failed to grow through the Jassid, and produced neither growth nor crop. The first two were the worst and Webber 49 the least bad. Mr. Wood's Tanganyika selection, Mp12, the local Griffin, and Improved Bancroft from Rustenburg gave a little better growth and produced occasional bolls. Over the Top from Nyasaland and the three local varieties, Improved Bancroft, Zululand Hybrid, and Uganda, were all decidedly better, though still of very poor growth, much damaged by Jassid, and producing very few bolls. Uganda was about the best of the last group. Z-1, the selection already described, was very much less affected by Jassid and produced a comparatively healthy growth and more bolls, though it was too late to give a normal crop. Cambodia was not damaged at all by Jassid, and gave the healthiest growth of the whole collection, but it was too late to give much crop.

The accompanying photographs (Figs. 5 and 6), taken towards the end of April, will give some idea of the differences described. The single plants photographed were chosen to represent as nearly as possible the average condition of the varieties from which they were taken. Fig. 7 shows the enormous difference between Cambodia and Webber 49 grown on adjacent plots.

There is little doubt that Jassid was the chief immediate factor in preventing a better development in the varieties that failed utterly. Had they been planted earlier and become well established before the Jassid got a hold on them, or had the conditions been a little more favourable, they would probably have been less devastated by Jassid, and greater differences might have been visible. The new American varieties were specially disappointing and, though they did not get a very good chance, there appears to be little hope of any one proving useful. Over the Top might possibly be of some use; it was a nice compact type of plant and fruited well, but the resistant plants were all very short in staple.

JASSID.

It is necessary to deal with this pest in considerable detail as it affects the whole of the breeding work on the station; moreover, a good deal of time has been spent during the season in studying various aspects of the problems it provides.

Much of this work, including that on hairs, cage experiments, and notes on the life-history of the insect, has been carried out by Mr. J. L. Moerdyk, a holder of one of the Corporation's Studentships, who worked on the station throughout the season. I should like to record my appreciation of the keenness and energy that he devoted to the work. The difficulties were considerable as the station was ill-equipped at the time for such work.

Importance as a Pest.

Jassid has been reported as a serious pest, in various seasons, in practically all areas of the low veld from near Louis Trichardt in the north to Natal in the south. It is very irregular in its occurrence and in the damage it causes, varying from season to season in the same place and from place to place in the same season. In a few areas, where it has not done much damage so far, it is possible that it may never prove very serious. It is too early to form any judgment on this point, however, as cotton has not been grown on a large scale for a sufficiently long time, and it is safer to assume that all low veld areas are liable to attacks. In some tracts, on the other hand, more or less severe attacks have occurred so often that Jassid has already become a very definite limiting factor in the production of a paying crop.

One of the advantages of the low veld is its long season and the possibility that this offers of obtaining a useful top crop to make up for possible deficiencies in the main season. This advantage may be, and in many places has been, regularly nullified by Jassid. For this reason alone, apart from heavy loss that it may cause in the main crop, Jassid is a most important factor in the low veld.

Effect on the Crop.

In the very early stages of an attack a slight yellowish or brownish discoloration appears towards the margin on leaves that are nearly full grown. The discoloured area is irregular and often limited in places on the inner side by veins. At this stage one or two Jassid nymphs can generally be found on the under side of such leaves. The discoloration gradually becomes more pronounced, especially at

the edges, and the leaves become somewhat curled or crumpled with the edges turned down. By this time most of the leaves on the plant will be showing the attack and the crop will be rapidly losing its healthy appearance; several nymphs will be found on each leaf, and the flying insect will be more in evidence. If the attack is very rapid the bulk of the leaves may turn brown and dry up on the plant. More commonly a general reddening takes place from the margin of the leaf inwards, the older leaves are gradually shed, and the younger ones dry up. Some strains habitually turn brown without any marked reddening, especially those with a rather thin light green leaf. By the time the general reddening is pronounced swarms of flying Jassid appear on the plants, and up to seven or eight nymphs per leaf may be found.

With the reddening of the plant development ceases, squares and very young bolls are shed, partly developed bolls dry up, and only those that are nearing maturity ripen off and open naturally. A certain proportion of the latter always produce weak lint, due to their development having been arrested at too early a stage.

In the last stage of a bad attack, anything from six to ten weeks after it first started, the plant becomes entirely leafless. It may still remain alive, but it is generally too far gone to recover and produce a later crop, though a small amount of new growth may be made if the Jassid disappears early enough. In particularly bad cases the bulk of the plants may be killed outright, but this is not common.

The actual loss due to Jassid depends on the stage at which the attack develops. In bad cases the greater part of the main crop of bolls may be destroyed; where the attack is later in developing only the late top crop is lost. Very occasionally an early mild attack may pass off without destroying the larger bolls, and in time for a top crop to develop.

The Responsibility of Jassid.—The species of Jassid found on cotton in South Africa is *Empoasca fascialis*, and the word "Jassid" throughout this report is intended to mean this species.

One sees very different views and statements as to the real cause of the damage commonly ascribed to Jassid. Experience of this pest did not leave much doubt that it was justly accused of complicity at the least, but further knowledge was necessary in the study of resistance. The following experiments, carried out by Moordyk, were designed to give some definite information on the question.

Eight similar plants were chosen near together in a plot of Watts' Long Staple, a very susceptible variety, and a cage of fine wire screening (1,600 meshes to the square inch) was placed over each.

The plants were all about 16 inches in height, and so infested with Jassid that growth was at a standstill. They were marked in pairs, as nearly equal as possible, and fumigated on February 14. Calcium cyanide dust was used, sprinkled on the soil under a covering, and all Jassid were killed without damaging the plants. An interval of eight days was allowed for eggs to hatch, and a second fumigation was given. Jassid nymphs in various stages, about 250 to 300 per plant, were then introduced into one cage of each pair, and the other was kept as a control.

The day following the first fumigation the plants looked better; all improved rapidly, the less damaged leaves became greener and flatter, and a vigorous growth was started before the second fumigation. The control plants all continued to grow vigorously, and remained perfectly healthy till the end of the experiment. Where Jassid was introduced the effect was very marked, as will be seen from the tabular statement that follows. All the infested plants behaved in the same manner, and there was little to choose between them.

<i>Days.</i>	<i>Condition of Plants.</i>
1	Few leaves wilting.
2	Yellowing of margins of leaves.
4	Few leaves nearly dead.
6	Jassid mostly reached winged stage; deterioration slackening; controls 3 inches taller.
9	No nymphs left; new growth just starting.
13	Few nymphs of new generation; plant recovering rapidly.
17	Many young nymphs; height 20 inches, controls 32 inches.
20	New "Jassid" effect visible.
28	Growth entirely stopped and plants dying.

Fig. 8 shows an infested plant and a control at the end of the experiment; the former was quite brown and the latter green and healthy.

Similar results were obtained with two pairs of much larger plants, but in this case the ups and downs were not quite so rapid. In another experiment two forked plants were used, and the opposite sides of the forks were caged separately, one as a control and one with Jassid in each case. The results again were the same; the infested sides were killed, and the control sides grew healthily. The two sides were approximately equal before the introduction of Jassid, but the difference one month later will be seen from Fig. 9.

In all the above cases the effect on the plant was of the same nature as is seen in an attack of Jassid in the field, except that very little reddening of the leaf occurred, the discoloration being yellowing at first and then browning. The reduction of light intensity inside the cages was probably the reason for this.

The results were very definite, and showed conclusively that Jassid is directly concerned in the damage ascribed to it. Furthermore, they indicate the very great improbability of Jassid being merely a carrier of some organic disease that does the real damage. When a plant recovers after fumigation, leaves that had been crumpled and discoloured become flat, much greener and healthier; the yellowish and brownish markings largely disappear, but red marks remain. It is most unlikely that such a decided recovery would take place if an introduced organism were concerned.

In another type of experiment glass rings ($\frac{3}{4}$ inch in diameter), as used for hanging-drop culture cells, were used as miniature cages for Jassid. A perforated card lid was placed over one side, and the other side was applied to the leaf. The whole was kept in position on the under side of the leaf by a wire clip, an open ring being placed on the other side of the leaf as a support. The result was very satisfactory, and nymphs placed in such a cell appeared to be quite comfortable. Six nymphs in one or two days produced a very definite yellow circle on the leaf, the time taken varying with the temperature, which presumably affected the feeding, and with the variety of cotton. If the cell was removed early enough, before the yellowing was very strong, the patch recovered completely in about two days. If allowed to remain for too long the tissue died. Similar cells without Jassid inside were used as a control, but never showed any effect.

The yellowing was very evenly spread, and always ended just short of the glass, the unaffected ring probably being a part that was out of reach for feeding purposes. Whatever the position of the cell on the leaf, the result was the same, and in no case was there any spreading from the original circle. Figs. 10 and 11 show the type of result obtained very clearly. In both cases it is the upper side of the leaf that is visible, the rings seen in No. 10 being only the supports.

It is obvious that the effect of the Jassid is confined very narrowly to the actual spot that it punctures in feeding. There is certainly no infection that spreads after it is introduced, and here again the recovery that can take place is very strongly against the possibility of a disease organism being concerned.

Professor Hector of the Transvaal University College, Pretoria, was kind enough to undertake the preparation of cultures from damaged leaves sent from Barberton. The leaves were taken from an ordinary crop badly damaged by Jassid. In all cases bacterial infection was found, and some pure cultures were made and sent

down for inoculation experiments. The cultures were spread on the leaf surface and pricked in with a needle. Out of a large number of inoculations only one showed any effect, a slight evanescent yellowing, but this was unlike the typical "Jassid" effect. Further experiments on these lines are required with cultures from properly controlled material.

The fact that, in an ordinary attack, the first effect is a discoloration towards the margin of the leaf had suggested the possibility of a toxic injection, from punctures over the general surface, passing out and becoming concentrated in that part of the leaf. When using the ring cells, however, no indication of any such distant effect could be detected, even when the cell was situated over a small vein. A few nymphs can produce such rapid damage—ininitely more, for instance, than the same number of aphids—that the actual withdrawal of cell sap cannot well be the main factor. A more likely possibility is that some toxic secretion is injected, but no attempt has yet been made to test this theory. A careful examination of the affected tissue and further experiments are necessary before the nature of the damage can be determined.

It should be noted that, from observations made in experiments with both large cages and small cells, the adult Jassid appears to produce very much less effect than the nymphs, but the larger the nymphs the greater the effect produced.

Susceptibility.

Condition of Growth.—There is no doubt that, other things being equal—i.e., when dealing with one variety—susceptibility to Jassid depends very largely on the condition of the plant. Speaking generally, a vigorous growth increases resistance, whereas any retardation of growth, to whatever cause it may be due, appears to increase susceptibility.

A young crop is generally more free from Jassid than one that is older, due to its more vigorous growth, but the position is reversed in cases where the older crop is more vigorous. A heavy crop of bolls tends to ripen off the plant and thus increase its susceptibility, a fact that makes the judging of selections a matter of some difficulty.

The effect of drought in checking a crop very commonly predisposes it to Jassid. This has been noticeable during the past season in this district, where some of the light, shallow soils have been badly hit. The severe attack on the station may be put down to the same effect, in that the dry season was accentuated by the loose, open state of the newly-broken land. In the previous season

cases were seen where poor growth due to waterlogging appeared to increase susceptibility in a similar manner.

The nature of the soil affects the growth of the crop considerably, and with this the behaviour to Jassid. A striking example of this nature was afforded by an estate with areas of red loam, passing over, in very short distances, to a heavy black soil very like the black cotton soil of India. In fields containing both types of soil, treated uniformly, the plants on the red soil grew more quickly and fruited early, whilst the black soil plants were slower in growth, smaller, and late in fruiting. The red soil crop became infested with Jassid as it was growing mature, whereas at the same time on the black soil the crop was much less advanced, still growing, and showed little effect of Jassid. Much more experience is required before attempting to analyze the causes of such variation. That different types of soil produce different types of growth is beyond doubt, but it remains to discover what are the chemical and physical factors concerned. It is quite uncertain whether such different types of growth would show the same susceptibility to Jassid if they could be brought to the same physiological stage at the same time.

Plant Food Deficiency.—There is little evidence that plant food deficiency, which has been found by Evans and Ballard to be a predisposing factor in Australia, is of importance in South Africa. There are, no doubt, some cases where poor growth due to poor soil enhances susceptibility, but they are not very noticeable and are overshadowed by the numberless cases where strong, healthy cotton on good land is very badly attacked.

Many of the soils are deficient in phosphate, and this is the commonest fertilizer that is used for cotton. I have never been able, however, to detect any difference in resistance to Jassid between a crop receiving superphosphate and a neighbouring one without. My own crop received 300 lbs. per acre in 1924-25 and 200 lbs. in 1925-26, applied at or before planting, but this did not prevent susceptible varieties from suffering very severely. In the past season a bad attack occurred on land that had received about 250 lbs. of superphosphate yearly for three years.

The majority of soils are rich in potash, and general experiments conducted by the Department of Agriculture have indicated that it is not required in the ordinary way on other crops. I have not seen it used on cotton in general farming.

Nitrogen is not commonly applied to cotton, but heavy dressings are used for tobacco. Cotton following tobacco gets a good deal

of residual nitrogen, and generally gives a better crop than usual, but such a crop is still liable to suffer severely from Jassid.

During the last two seasons a series of plot experiments have been conducted to test the effect of various fertilizers on the plant from the point of view of susceptibility to Jassid.

In the 1924-25 season sulphate of ammonia, nitrate of soda, and chloride of potash were applied separately, at the rate of 500 lbs. per acre, as a top dressing. The crop had already received 300 lbs. per acre of superphosphate put in at the time of planting. Each plot was three rows by 50 yards long of Watts' Long Staple. The dressings were hand-sown along both sides of the rows, and hoed in on March 20. This was later than had been intended, owing to delay in getting the fertilizers, and the cotton was just showing signs of Jassid. Some further growth was made, however, before Jassid became bad, and the fertilizers should have produced some effect. Regular observations showed no visible differences, and by the end of April all three plots, together with the untreated rows, were quite red, and no crop was produced. This was a season of plentiful rainfall.

In the past season, 1925-26, similar plots of Improved Bancroft, three rows by 75 yards, were dressed with superphosphate at 200 lbs. per acre, potash at 200 lbs., and guano at 500 lbs., after having received 200 lbs. per acre of superphosphate a few weeks previous to planting. The dressings were applied on February 2, when the plant was still small and Jassid had hardly appeared. Unfortunately, though a good deal of further growth was made, the crop was never in a strong growing condition, and Jassid increased rapidly. It seemed possible to detect a very slight superiority in the growth of the guano plots, but no difference whatever could be seen as regards susceptibility to Jassid. All plots were practically finished by the beginning of April, and gave no appreciable crop. The growth made after the applications appeared to be sufficient for the fertilizers to show some beneficial action if plant food deficiency was an important factor. In future experiments of this nature, however, the dressings will be applied at the time of planting in order to give the fertilizers more time to act.

The Improved Bancroft used in the above experiment was the usual mixed variety, and occasional resistant plants stood out here and there, thus illustrating the importance of hereditary Jassid-resistance as compared with soil treatments.

A similar set of top dressings, but in this case including nitrate, potash and phosphate together, in addition to each of the three

separately, were applied across plots of Watts' Long Staple, Rustenburg Bancroft, Delfos, and Express. Here again no differences could be seen, but in this case very little growth took place after the applications, as Jassid kept the plants down very thoroughly. The difference between the relative growth of a resistant strain with no fertilizer and of a susceptible variety supplied with abundant plant food may be seen by comparing Z.1 of Fig. 6 with Delfos in Fig. 5. It is possible that Z.1 is more drought-resisting than Delfos, but in the previous very wet season the difference was also very marked.

From the evidence available I am doubtful whether the prevalence of Jassid in this district is to any appreciable extent connected with plant food deficiency. Further experiments will be carried out for one or two more seasons, however, to gain additional information on this point.

Varietal Resistance.—The description already given of selections and varieties indicates the enormous differences they show in their behaviour to Jassid. The chequered appearance of the groups of plots when Jassid was prevalent was a most striking indication of the importance of this side of the problem.

As between different strains, vigour of growth was not a deciding factor in resistance, though some slight connection could be traced. Certain selections started well, maintained better growth than the average during dry spells, and were marked down as specially healthy types. Some of these, however, became badly infested with Jassid at a later stage and had to be discarded. Less robust lots occasionally showed unexpected resistance, though some of the poorest lots were the first to succumb.

The same applies to lateness, which is generally associated with resistance. One or two very late lots probably owed their resistance to that factor, but in the general run of the selections there was little apparent connection, and some of the best strains were comparatively early.

A few selections were decidedly mixed as regards Jassid-resistance, and one lot exhibited two very definite types. In view of the different associations of characters found in the two types of this lot, however, it is held under suspicion, as a possible accidental mixture, until proved otherwise.

A cross between Cambodia and Watts' Long Staple was made in the previous season, and the F.1 this year exhibited a high degree of dominance of the Cambodia habit and Jassid-resistance (*vide* Fig. 12). The F.1 was rather less hairy than Cambodia, and showed slight damage by Jassid. A few crosses between Cambodia

and various selections have been made this season, also between selections of Z.1 and Bancroft. Occasional natural crosses by Cambodia, easily recognizable, have been found in varieties grown from unselfed seed that were growing near Cambodia in the previous season. In all cases they showed a resistance only very slightly less than that of Cambodia. A natural cross of this type in a plot of Cleveland is shown in Fig. 13.

Nature of Resistance.

It is probable that the differences shown by various strains in their resistance to Jassid are due to various combinations of numerous factors. Chemical and physical attributes of the plant may affect the attraction, feeding, and breeding of the Jassid, thus influencing the weight of the attack, and different degrees of tolerance for the pest may affect the resultant damage to the plant.

Some interesting figures were obtained by Moerdyk on the varying degrees of infestation of strains markedly different in resistance. Jassid nymphs were counted, at various dates, on five leaves from each of two plants for each variety. The leaves were all of the same stage, just about fully grown, and the varieties were growing under the same conditions. The figures, given below, show very wide differences in the amount of infestation. It is possible that degrees of resistance might be estimated fairly accurately by such counts on a larger scale.

<i>Variety.</i>	<i>Resistance.</i>	<i>Number of Nymphs on Ten Leaves.</i>				
		<i>Feb. 19.</i>	<i>Feb. 22.</i>	<i>Mar. 1.</i>	<i>Mar. 11.</i>	<i>Mar. 27.</i>
Watts' Long Staple ..	Very bad	33	55	47	75	68
Bancroft Strain ..	"	34	47	81	81	72
Z.1.9" .. " ..	Good	1	1	3	10	28
Z.1.9" .. " ..	"	3	2	2	12	8
Cambodia .. " ..	Immune	—	—	—	—	—

That chemical factors play some part appears very probable from the relation already described between development of Jassid and the condition of growth of the plant. It is possible that the acidity of the cell sap varies with the condition of growth and stage of development of the plant, also that it varies in different varieties. It is proposed to make hydrogen ion determinations that should throw some light on this question.



FIG. 1.—A TYPICAL PLANT OF Z. 1.9 ON APRIL 24, 1926.
Still green and growing; bolls healthy.



FIG. 2.—A TYPICAL PLANT OF WATTS' LONG
STAPLE, APRIL 24, 1926.
Brown and practically dead; immature bolls
dry and splitting.

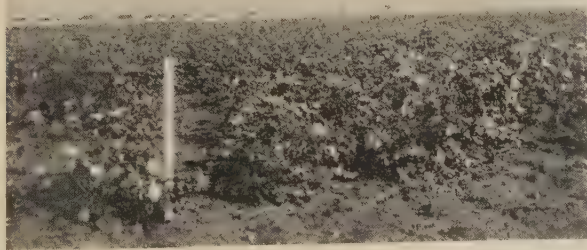


FIG. 3.—A PLOT OF
LOCAL IMPROVED
BANCROFT, APRIL
24, 1926.

Miserably small
and practically
leafless.

FIG. 4.—A GOOD
BANCROFT SELEC-
TION (THE FOUR
ROWS TO RIGHT OF
STICK), APRIL 24,
1926.

Well grown and
still full of leaf.



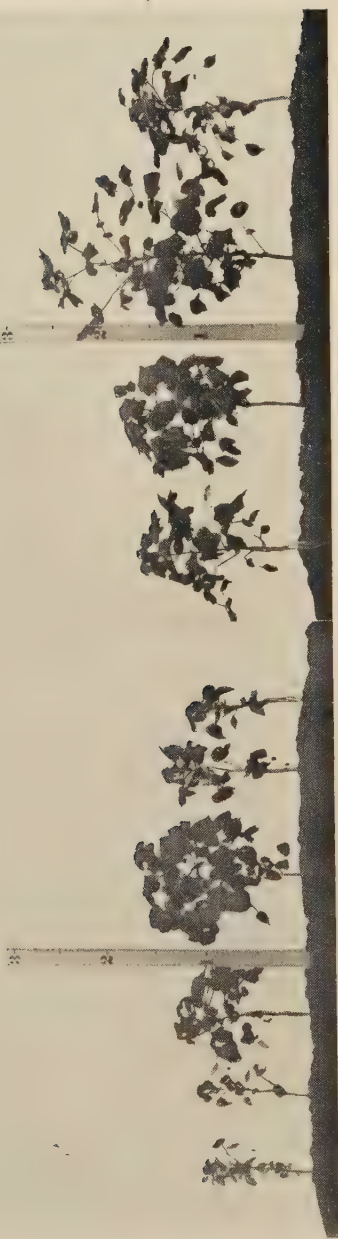


FIG. 5.—AVERAGE PLANTS OF SOME INTRODUCED VARIETIES,
APRIL 24, 1926.

Left to right, Acala, Delfos, Webber 49, Over the Top,
Belton, and Rowden.



FIG. 6.—AVERAGE PLANTS OF LOCAL VARIETIES,
APRIL 24, 1926.

Left to right, Zululand Hybrid, Uganda, Z. 1
Selection, and Improved Bancroft.



FIG. 7.—ADJACENT PLOTS OF WEBBER 49 (LEFT) AND
CAMBODIA (RIGHT), APRIL 24, 1926.



FIG. 8.—TWO PLANTS FROM CAGES.
Left, free from Jassid; right, with Jassid introduced.



FIG. 9.—A FORKED PLANT IN WHICH THE
TWO SIDES WERE CAGED SEPARATELY.
Left, free from Jassid; right, with
Jassid introduced.

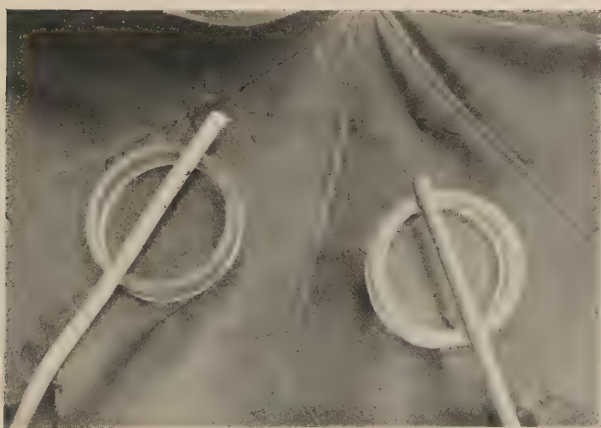


FIG. 10.—EFFECT OF
JASSID CONFINED IN
RING CELL ON THE
LEAF.

Left, without
Jassid; right, with
six nymphs for
twenty-four hours.
Note the dis-
coloured area not
quite touching the
glass.

FIG. 11.—As No. 10,
BUT WITH RINGS
REMOVED.

The yellow circle is
very well defined;
the appearance of a
slight outer ring
above is due to
lighting on the bent
leaf. The control
cell has produced no
effect.





FIG. 12.—TYPICAL PLANTS OF WATTS' LONG STAPLE (LEFT), CAMBODIA (RIGHT), AND THE FIRST CROSS (MIDDLE), APRIL 24, 1926.

W.L.S. brown, Cambodia green, the cross with slightly reddened edges.



FIG. 13.—A NATURAL CROSS BY CAMBODIA IN A PLOT OF CLEVELAND, APRIL 24, 1926.

The latter is so small and brown as to be scarcely visible.

Of physical properties of the leaf, hairiness has received considerable attention, but no examination of leaf structure has yet been made. Hairiness is well known to be connected with resistance, and, as has been stated already, the connection was very noticeable this season.

Hairiness.—Moerdyk has made counts of hairs on the under-surface of the leaves of a number of strains showing a wide range in Jassid-resistance. One leaf, just fully mature, was taken from each of three plants in each strain. Immediately after picking two discs were punched from each leaf, in the same positions in each case, by means of a cork-borer. The six discs for each strain were mounted on a slide with the undersurface of the leaf uppermost. The hairs were counted under a binocular microscope, of which the field just covered one disc. To facilitate counting the field was divided into sixteen smaller areas by a home-made set of cross wires in the eye-piece. The area of each disc was 37.6 square mm., and from the numbers of hairs on six discs the average density per square millimetre was calculated. In addition to counting the hairs notes were made on their length, together with some rough measurements.

The work was very tedious, but the results are interesting and form a useful preliminary record. The figures are given below, together with the notes on hair-length, the strains being arranged in their order of resistance.

<i>Strain.</i>	<i>Resistance.</i>	<i>Hairs per Square Mm.</i>	<i>Hair Length.</i>
Cambodia	Immune	4.1	All long.*
Z.1. × Cambodia ..	Very good	4.4	Mostly long.
U.2.	"	4.7	"
Pima × Cambodia ..	Good	5.4	"
Z.1.9... ..	"	4.2	Variable.
Z.1.5... ..	"	3.8	Very variable.
B.23.	Rather good	6.2	Variable.
B.27.	Moderate	5.1	Mostly medium.
B.120.	Poor	5.4	Mostly short.
B.111.	"	3.1	"
Z.1. × Pima	Bad	3.1	Short.
Z.1.11.	"	1.8	"
Z.141.	"	1.1	"
Crump	Very bad	1.8	Mostly very short.
Watts' Long Staple..	"	1.4	All very short.†

It will be seen that the density of the hairs falls off considerably in most of the really susceptible lots, but there is a much closer connection between hair length and resistance. Thus B.120, a poorly

* 1 to 2½ mm.

† ½ to ¾ mm.

resisting lot, shows a high density, though the hairs are mostly short. It is unfortunate, in view of the fact that hair length appears to be of great importance, that this character could not be determined accurately at the time owing to the lack of an eyepiece micrometer. The hairs are borne in bunches of varying numbers, and the length of individual hairs and angle at which they are set also vary considerably. A large number of measurements and detailed notes would be required to give a satisfactory idea of the differences in hairiness, and it is hoped to carry out further work on these lines in the coming season.

The actual nature of the connection between hairiness and resistance is not known. It may be simply mechanical, due to the hairs themselves, or due to a correlation between hairiness and some unseen factor affecting Jassid. A purely mechanical explanation would seem to be quite reasonable, however. When Jassid nymphs are placed on a Cambodia or other very hairy leaf they appear to find it anything but comfortable. They are fidgety, active little creatures, and spend their time struggling with the hairs, in a manner suggesting resentment, instead of trying to burrow through to their food. In spite of this, however, they have been seen to survive on a Cambodia leaf, and must, therefore, be able to feed fairly well. They would be much more vulnerable to their enemies on hairy leaves owing to their movements being very much impeded. Presumably the adult female is responsible for their comparative absence from hairy leaves, and it is possible that the very hairy midribs and petioles deter her from ovipositing.

Tolerance.—Field observations indicate some variation in the tolerance to the action of Jassid shown by different strains. One strain may hang on, getting worse very slowly in spite of heavy infestation, whereas another may collapse rapidly without any appreciably greater infestation being evident.

By the use of the glass ring cells described above for confining Jassid on leaves of different strains it was possible to form some opinion of such tolerance. Six nymphs were placed in a cell on the leaf for twenty-four hours and the amount of discoloration noted. By using nymphs and leaves of the same stage of development and making simultaneous trials, it was found that there was a fair degree of uniformity in one strain, but differences were shown between strains. This method was only started towards the end of the season, however, and no large number of trials could be made. A demonstration of differences in this manner, of course, would possibly mean nothing more than that the nymphs feed less readily on some

strains. Thus Cambodia appears to show considerable tolerance, but this may be largely due to the fact that the nymphs find difficulty in feeding on its very hairy leaf. Whether tolerance is a factor of real importance can only be judged after more experience.

Life-History.

No detailed study of the life-history was attempted, but the following notes were made by Moerdyk during the course of his work.

A collection of Jassid from cotton and other crops on the station was sent to Dr. Naude of the Entomological Division, an authority on Jassid taxonomy. He found only one species (*Empoasca* [*Chlorita*] *fascialis*) in the collection from cotton, and the same species, mixed with one other in each case, from both groundnuts and Tepary beans.

The adult is about 4 mm. in length, very active, both on the wing and in its crab-like movements on the leaf. They are known to feed, but, as already stated, they produce little effect on the plant as compared with the nymphs.

The eggs are sickle-shaped (0.7 to 0.9 mm. long by 0.15 to 0.2 mm. in thickness) and greenish in colour. They are entirely embedded in the tissue, and cannot be seen without dissection. They have been found in the midrib and larger veins of both surfaces of the leaf, and in the petioles and young stems, but never in the leaf lamina. The puncture is at right angles, but the egg lies parallel to the surface at a depth of from two to three times its own thickness. Shells found *in situ* often exhibit spiral convolutions, suggesting a corkscrew-like movement in their insertion.

Nothing is known of the number of eggs laid by one female, but up to four fairly mature eggs can be found together in the ovary on dissection. The rate of multiplication is extremely rapid, and the female must be very fertile.

Early in the season, about February, the incubation period appeared to be from eight to ten days, but it became longer later in the season.

On hatching, the young nymph finds some difficulty in emerging from the narrow orifice. This is accomplished by a wriggling movement, the legs being folded against its body and not brought into action till it is practically out. The whole operation takes a few minutes to half an hour or more, and it was the finding of nymphs in the half-out position that led to the discovery of the eggs. The insect must be very vulnerable at this stage, as it is immobile and quite

helpless. Hatching takes place principally from 8 to 9 a.m., a warm night and muggy morning appearing to encourage it.

The nymph is transparent when first hatched, but soon starts feeding, and assumes a greenish colour by the second day. The number of moults was not ascertained, but the whole nymphal period occupied about ten days in February and March. The complete cycle, egg to egg, takes from twenty-five to thirty days in the early part of the season, and becomes longer as the season advances.

Little is known of this species during the winter except that adults can be found in sheltered places on various forms of herbage. From the extremely efficient manner in which the eggs are protected it seems likely that they might also overwinter in this stage in some evergreen type of foliage.

No literature on any of the Jassidæ could be obtained before the work was started, but at the close of the season a very useful paper was found in the Division of Entomology, "Bionomics and Control of Potato Leafhopper, *Empoasca Mali Le Baron*," by Fenton and Hartzell, *Research Bulletin*, No. 78, Iowa State College of Agriculture. This paper would have been of great assistance had it been received earlier, as the descriptions given by these authors of the species, the damage it causes to the potato, and of resistant varieties, is strikingly similar to our experience of the Cotton Jassid.

RAINFALL RECORD (JULY 1925-JUNE 1926).

1925.		<i>Inches.</i>	1926.		<i>Inches.</i>
July	..	Nil	January	1	0.49
August	..	Nil	"	2	0.64
September	10	1.08	"	5	0.46
"	11	0.19	"	9	0.36
"	13	0.34	"	18	0.12
"	14	1.10	"	25	0.05
"	15	0.19	"	26	0.38
"	23	1.18	"	27	0.08
		— 4.08	"	31	0.79
October	3	0.01			— 3.37
"	6	0.05	February	1	0.28
"	11	0.94	"	8	0.08
"	16	0.16	"	11	0.42
"	17	0.46	"	12	0.04
"	20	0.23	"	16	1.39
"	21	0.21	"	18	0.06
"	22	0.07	"	22	0.41
		— 2.13	"	23	0.38
November	3	0.92	"	24	0.03
"	4	0.22	"	25	0.14
"	5	0.03	"	26	0.30
"	11	0.05	"	27	1.15
"	24	0.40			— 4.68
"	27	0.22	March	5	0.15
"	28	0.06	"	7	0.01
		— 1.90	"	15	0.28
December	11	0.18	"	16	0.05
"	15	0.04	"	24	1.25
"	17	0.86	"	25	0.06
"	18	0.01	"	27	0.90
"	27	1.45	"	31	1.38
"	28	0.61			— 4.08
		— 3.15	April	9	0.40
			"	10	0.16
					— 0.56
			May	..	2.06
			June	..	Nil
					—
			Total for year ..		26.01 inches.

COTTON EXPERIMENT STATION, CANDOVER ESTATES, MAGUT, NATAL—REPORT FOR THE SEASON 1925-26

BY

F. S. PARSONS.

THE present report provides a discussion on observations carried out in this area over the twelve months' period September 15, 1925 to September 15, 1926.

The period has afforded a survey of planting-to-planting operations, as early seeding is fairly common in September.

Owing to localized and inadequate rainfall very poor growth conditions have prevailed during the past season. These conditions have naturally been reflected in low returns and have greatly inhibited field experiments. Following the unusually heavy rains of the past season, which wrought havoc with that season's crop, it is felt that the climatic vagaries of the region have been sufficiently expressed to permit a full harvest in the crop year now commencing. Past observations, though scantily recorded, would at least indicate that the seasons 1925 and 1926 have been abnormal.

South African soils are deficient in phosphorus over much their greatest portion. Experiments on the effects of applying phosphatic fertilizing materials to cotton have been set out in series, which are standard, in various parts of the Union. There are four such series under the writer's supervision. Two of these are situated on the Lebombo Flats near the Pongola River, an area which differs in soil and climate from the hill and valley country round about Magut, where the other two series are situated.

The plots lie on different general soil types, each site being generally representative of large areas of arable land.

Conventional soil analyses of the sites have been made in the Union Government Chemical Laboratories, Pretoria. Total P_2O_5 is practically non-existent.

The arrangement of the plots is as shown on p. 47.

The plots are each $\frac{1}{16}$ of an acre in extent. Between each plot are two rows of cotton which would be cut prior to harvesting. The series are spaced 15 feet apart and the margins of the whole are surrounded by a belt of twelve rows. The cotton bushes in the inter-series spacing of 15 feet, together with one or two rows of the marginal belt, would be cut out prior to picking operations.

TABLE.

Super	Slag	Slag 2	Check
Super 2	Slag 2	Check	Rock 2
Super 3	Check	Slag 2.2	Rock 2.2
Check	Slag 3	Slag 2.3	Rock 2.3
Super	Slag	Slag 2	Check
Super 2	Slag 2	Check	Rock 2
Super 3	Check	Slag 2.2	Rock 2.2
Check	Slag 3	Slag 2.3	Rock 2.3
Super	Slag	Slag 2	Check
Super 2	Slag 2	Check	Rock 2
Super 3	Check	Slag 2.2	Rock 2.2
Check	Slag 3	Slag 2.3	Rock 2.3
Super	Slag	Slag 2	Check
Super 2	Slag 2	Check	Rock 2
Super 3	Check	Slag 2.2	Rock 2.2
Check	Slag 3	Slag 2.3	Rock 2.3

KEY TO TABLE.

Super = light or half normal dressing of superphosphate (100 lbs. per acre).
 Super 2 = normal dressing of superphosphate (200 lbs. per acre).
 Super 3 = heavy or double normal dressing of superphosphate (400 lbs. per acre).
 Slag = half normal dressing of basic slag.
 Slag 2 = normal dressing of basic slag.
 Slag 3 = double normal dressing of basic slag.
 Slag 2.2 = normal dressing of basic slag every alternate year.
 Slag 2.3 = normal dressing of basic slag every third year.
 Rock 2 = normal dressing of rock phosphate.
 Rock 2.2 = normal dressing of rock phosphate every alternate year.

It is convenient to discuss briefly here the past season's progress of these plots.

The series are named:

- | | |
|------------------|-----------------------|
| 1. Arizona | } Magut area. |
| 2. Kingholm | |
| 3. Pongola Poort | } Lebombo Flats area. |
| 4. Lebombo | |

Arizona Series : Red Loam Soil Type.—The land had borne cotton for two years.

The first planting (November 16) gave a scanty germination which experienced heavy mortality in the succeeding drought. The remaining plants were harrowed out.

The second planting (December 30) following rain gave an excellent germination, and growth was rapid while soil moisture was available. Succeeding rain was of a showery nature. The plant growth, therefore, only attained meagre proportions, and fruit set prematurely. A bad attack of Sudan Bollworm occurred in March, and the fruit and bud shedding through this agency precluded any hope of data in view of the advanced season.

Kingholm Series : Shale Soil Type.—The land had borne cotton for two years.

First planting, November 21. The germination was very poor and succumbed to drought, as above.

Second planting, December 30. Germination good.

It is not proposed to submit rainfall, temperature, and other data for these plots for the past year. Suffice it to say that under the greatly localized conditions of rainfall in the district (falls varying by as much as 1.5 inches over a half-mile radius) these plots progressed favourably until March, when daily flowering records were commenced to assess the influence, if any, of phosphorus in stimulating earliness. Consistent with experience throughout the entire area, however, a bad attack of Sudan Bollworm destroyed flower buds to such an extent that flowering curves were unobtainable. Of flowers marked to measure the boll maturation periods only 10 per cent. were recovered as normally opened bolls, bollworm being mainly responsible for the remaining 90 per cent.

Insufficient seed cotton was picked from the plots to enable any reliable statistical conclusions to be drawn, but such figures as have been secured for these characters do not offer any significant difference between check plots and the variously treated fertilizer plots. It is regretted that the plots have been of necessity sown with commercial Zululand Hybrid seed, which is badly mixed, to say the least. Before termination of the experiments, which will run for five years, there will be available a reasonably "pure" strain for seeding these plots, amongst other areas, and consequently results may reveal points of difference in lint, seed, and other characters, at present obscured.

As stated, insufficient recoveries of open bolls from marked flowers preclude statistical treatment of the data. It may be of interest to note, however, that flowers marked from March 30 to April 30 required from 75 to 90 days for the period open flower to open boll. Frost on July 22 and 23 indirectly occasioned the opening of bolls from April flowers, which would not have opened probably for over 100 days from the open flower stage.

Root behaviour was so varied that no conclusions could be drawn.

Pongola Poort Series: Red Soil Type (Highly Colloidal).—The early planted crops in this area yielded small returns, having in all probability had access to residual moisture from the heavy and late rains of the previous season. On the whole, however, poor yields are reported for the main crop, owing to lack of rain.

The fertilizer plots here barely produced a few debilitated plants. The fertilizer materials were not received until November 9, and

thus the planting dates were considerably in arrear of those of the main crop.

Lebombo Series : Heavy Black Soil Type.—No stand was secured on this site.

STANDARD VARIETY TEST.

The standard variety test referred to by Mr. Parnell in the "Reports from Experiment Stations, 1925," has been continued.

Zululand Hybrid, Bancroft, Uganda, Griffin, and Improved Bancroft were the commercial lots sown in accordance with the general plan.

For the first sowing, which did not germinate, blocks were fastened to the wheels of a cotton planter at measured intervals on the circumference for use as markers. In consequence of the damage seen elsewhere, occasioned by crickets, cutworms, wireworms, and a leaf-eating beetle (*Syagrus rugifrons*, Baly), it was decided to replant the land, using a planter in the ordinary way, in an effort to ensure, with the aid of poison bait, a sufficient remainder of healthy seedlings. The thorough cleaning of the planter drums after each "strain" was not found difficult or inordinately delaying.

The site chosen for the variety test proved to be most unfavourably situated in point of rainfall, it being one of the driest. The test came to nought, mainly through drought, but the bollworm accounted for most of the fruit which did set.

SPACING EXPERIMENTS.

A spacing experiment embodying refinements of precision for use with the present mixed cotton population, untutored hand labour, and the method used over the large areas in crop here, does not appear to be warranted at the present time. For future reference, however, a closer approximation to the optimum drill interval is being sought on the main experimental block during the coming season.

The spacings adopted for preliminary trial are as follows: In the drill, 6, 12, 18, 24, 30, and 36 inches. Between the rows, 3 feet 6 inches in all cases. Such experiments were set out in a quadruplicate series on the writer's temporary experimental block, and also co-operatively on five sections of the neighbouring area, each being on a different soil type, generally representative of a large acreage.

The main experimental block (since abandoned) happened to be

adjacent to the standard variety test, and experienced the same moisture difficulties. No results whatever were secured from it.

Of the co-operative experiments, it was decided to study only one. The remainder possessed scattered stands or experienced such late and unsatisfactory germination that any data drawn therefrom would be valueless.

The data presented below are taken from a co-operative experiment set out on a sandy loam site, probably deficient in humus.

The field in which the plots lie was sown between October 26 and November 6. Good moisture conditions prevailed at the sowing dates, germination was excellent, and the seedlings were well established before the water stringency of the succeeding eight weeks became pronounced. It is possible that tap roots had explored into the lower moist layers before that time; in any case a setback was experienced during the driest weeks, and had it not been for the relief of the two intermediate falls of approximately 0.4 inch each, replanting might have been necessary, as the soil possesses little retentive powers for moisture.

The land received the ordinary tillage of the remainder of the field.

The yields given are the sums for four lots of ten rows at each spacing. In total area each spacing (ten rows four times repeated) equals 1.7 acres, therefore the figures represent the total weight of seed cotton taken over 1.7 acres at that spacing.

YIELD: POUNDS OF SEED COTTON.

<i>Spacing.</i>	<i>6 ins.</i>	<i>12 ins.</i>	<i>18 ins.</i>	<i>24 ins.</i>	<i>30 ins.</i>	<i>36 ins.</i>
First pick ..	614	422	449	367	309	241
Second „ ..	557	564	551	566	453	499
Third „ ..	111	91	115	90	131	128
Total ..	1,282	1,077	1,115	1,023	893	868

The yield for the 12-inch spacing would have been greater without doubt had it not been for a washout of a portion of two rows which occurred during the heavy rainfall at the end of March.

With the exception of the above the stand was good and the intervals fairly regularly spaced, measured rods having been used for spacing.

Habit of Plants.—In the 6-inch spacing the plants were not notably spindly, but possessed a length of bare stem 10 to 16 inches long. The leaf and fruit scaffolding had a tendency to bunch at the top and mate with adjacent plants. The height of plants averaged 24 to 30 inches. The lower vegetative and other laterals were suppressed in the direction of the drill, and were not prominent across the rows.

It is judged that under more copious rainfall plants at 6 inches interval would develop a leggy habit.

In the 12 to 36-inch spacings the graded widening of the interval revealed, as would be expected, less suppression of branching in proportion to the increasing interval and reduction of the fruiting node height, and consequently better balanced plants.

In the 24, 30, and 36-inch spacings the habit is open and loose, the widest spacing tending to sprawl. The reference to the plant balance must be modified by these remarks.

Lint and Seed Characters.—The samples secured consisted of single seeds picked out of the respective bales at random. The mean measurements given below are those for 25 seeds or bolls, as the case may be.

<i>Spacings.</i>	<i>6 ins.</i>	<i>12 ins.</i>	<i>18 ins.</i>	<i>24 ins.</i>	<i>30 ins.</i>	<i>36 ins.</i>
Mean maximum lint length	30.5 ms.	31.5 ms.	32.6 ms.	32.5 ms.	32.5 ms.	32.6 ms.
Grader's estimate	Good 1½ ins.	Full 1½ ins.	Full 1½ ins.	Full 1½ ins.	Full 1½ ins.	Full 1½ ins.
Boll circumference at maturity ..	3.9 ins.	4.0 ins.	4.1 ins.	4.2 ins.	4.2 ins.	4.2 ins.
Mean seed weight	90 mgs.	90 mgs.	100 mgs.	100 mgs.	100 mgs.	100 mgs.
Mean weight of lint per seed.. ..	32 mgs.	32 mgs.	38 mgs.	38 mgs.	38 mgs.	38 mgs.
Lint index ..	3.2	3.2	3.8	3.8	3.8	3.8

Root competition per unit area has been reflected in the lesser dimensions of lint and seed characters drawn from the closer-spaced plants. This is in accordance with findings elsewhere and with unpublished data of the writer's investigation of the influence of restricting the supply of water to the cotton plant, as measured in the fruit.

Under pressure of duties elsewhere, it was not found possible to

arrange weekly pickings in these plots. The figures for the pickings indicate that the curves would probably have shown the initiation of earlier fruiting amongst the closer spacings.

Spacing Experiment: Two Plants per Hole.—Quadruplicate acre blocks were measured off in a fairly good stand. These were thinned to two plants at 18-inch drill intervals, and the yields compared with plots thinned to the usual one plant at the same drill interval. The yields were as follows:

YIELD PER ACRE: SEED COTTON (LBS.).				
Two plants per interval	..	..	..	459
One plant ,, ,,	..	..	..	377

The experiment leaves much to be desired in point of plot size, repetition, and layout in general. The plots were not picked under my supervision, and I am inclined to view the results with scepticism. The experiment will be repeated on a checker board plan and with amplification of the intervals.

Habit of Plants: Two-Plant Spacing.—It is observed that, as a rule, branching has been suppressed on the inner faces of the main stem of both plants. There is an arching over of the plants in the direction of the fruit-laden sides which throws the lower branches near the ground or on to the soil. Frequently a vegetative branch is pushed upwards perpendicularly to the soil surface. In these cases the stem of one plant may be erect and the vegetative branch of the other levers against it and forces over the bulk of the mother plant.

In a season of higher rainfall it is probable that these conditions would be aggravated and a large number of bolls be brought in contact with the soil. Soiling of the cotton would certainly occur, and possibly a percentage of boll rot, although the *Phytophthora* rot has not been seen here, and may not exist in South Africa. Cotton which had been beaten into and generously mixed with the soil during a storm in March graded "good colour," and it would appear that the modern gin makes light of earth soiling in cotton if certain soil components capable of staining are not present.

OBSERVATIONS ON INSECT PESTS.

Bollworms.—The American Bollworm or Corn-Ear Worm (*Chloridea obsoleta*, Fabr.) has not been an important enemy of cotton here during the past year. From September to July occa-

sional larvæ have been found. Reports from other cotton-growing areas, however, refer to heavy infestations of a migratory nature.

Local opinion has not regarded the Spiny Bollworm (*Earias insulana*)—there are two other so-called species in evidence—as important. The writer is inclined to believe that this worm occasions more damage than is recognized generally. Certainly in February random counts of bollworms in the field gave a 40 per cent. infestation of Spiny Bollworms. In terms of damage this worm, as an individual, probably does rather less than half as much damage to a capsule as an individual Sudan Bollworm (*Diparopsis castanea*). The abundance of wild food plants of the former, of which a preliminary list is appended, would maintain the presence of *Earias* in the face of successful measures for reducing the Sudan Bollworm population.

Preliminary List of Wild and Cultivated Food Plants of the Spiny Bollworms in Natal.—Vayssière and Mimeur¹ refer to various species of Hibiscæ and Malvaceæ serving as wild food plants of *Earias insulana* in Africa. Reference to their list has not been available.

The fruits of the following malvaceous plants are commonly found to contain Spiny Bollworms in this area. It may be remarked that *Abutilon soneratianum* is most heavily infested.

- Hibiscus calycinus*, Willd.
- Hibiscus cannabinus*, L.
- Hibiscus sabdariffa*, L.
- Hibiscus Rosa-sinensis*, L. (ornamental).
- Hibiscus esculentus*, L.
- Abutilon soneratianum*.
- Abutilon indicum*.
- Sida* (two species).
- Fugosia gerrardii*, Harv.

In addition to these are two other Abutilons, a *Fugosia*, and a *Hibiscus* not yet specifically identified.

A Probable Wild Malvaceous Food Plant of the Sudan Bollworm (Diparopsis castanea).—The Sudan Bollworm has not been known to feed on the structure or in the fruit of any plants other than wild or cultivated cotton plants, so far as the present writer is aware from publications.

Wild cotton has frequently been cited in this connection. According to Watt² the local wild cotton would appear to be *G. obtusifolium* Roxb., var. *africana*, Watt.

In the course of a preliminary study of the malvaceous flora of the area, a malvaceous plant has been found commonly bearing in

the fruit a larva indistinguishable from that of the Sudan Bollworm. It is believed to be the larva of *D. castanea*. The egg is identical, in all respects, as seen under a binocular microscope. The moth of, or a moth exactly like, the Sudan Moth has been found on different occasions in a characteristic position on the plants in question. However, the same moth has been frequently found taking cover on *H. esculentes* and *F. gerrardii*, but the larvæ referred to have not been so found. The larvæ when placed on cotton bolls readily bore their way into the interior. Some of these have pupated, and at the time of writing emergence of the moths is daily expected. It requires an examination of these to establish their identity definitely.

The plant appears to be of the genus *Fugosia*. Specimens were forwarded to Kew Gardens for identification by the Division of Botany, South Africa. Apparently the specimens were lost in the mails, as Kew Gardens reported their non-arrival. With the advent of spring growth, flowering material may be secured shortly, and the plant recognized specifically.

The influence of wild food breeding grounds of bollworms on the infestation of new cotton lands was evidenced by observations of the onset of the Sudan Bollworm in the crop on an isolated tract of newly broken soil. The field, if it could be called such, is seven to eight miles from old cotton lands. The intervening country is heavily bushed, and a range of hills offers an effective natural barrier, one would believe, having regard to the habits of flight of the moth.

When the plants on the field in question were bearing young buds, Sudan Bollworms were found at the rate of one per alternate plant. A month later the rate had risen to two per plant, and in March to five per plant. In the surrounding scrub were to be found occasional bushes of the wild cotton. These were infested with the bollworm, and it is presumed these gave rise to the infestation in the adjacent field. Around the older cultivated lands wild cotton is gradually being destroyed.

The incidence of a heavy attack of the Sudan Bollworm in March has been referred to. Prior to this the attack could be regarded as moderate. There did not appear to be anything in the nature of accumulated numbers, as successive generations arose which would account for the sudden wide and heavy infestation in March. Inhibition of natural enemies is suggested, but no evidence can be offered in support.

It has been rather generally accepted that the bollworms disappear entirely during the winter months—i.e., the latter part of June, July, and August. This has been found to be an erroneous acceptance

here. Field observations have revealed American, Spiny, and Sudan Bollworms in relative abundance up to the end of June; they are less easy to find in July, and rare in August. The American Bollworm has not been found since June; however, it has been rare at all times, as reported.

Undoubtedly much the greater percentage of mature larvæ in June and earlier entered on a long pupation period. In the last week of August evidence was received that a spring activity of the first flight of moths from winter pupation was commencing. In that week moths emerged in breeding cages, the purpose of which is discussed later, and on field observation plots eggs and larvæ became in evidence in appreciable numbers on the bracts and in the young buds of standover cotton left for trapping purposes.

The ratio of Spiny to Sudan Bollworms was then 5 to 1. Judging from their relative sizes the Spiny had been there at least a week earlier.

The value, for purposes of trapping bollworms, of strips of cotton left in the fields, after the cutting over of the main stand, will largely depend on the times and percentages of the spring emergence of the moths.

Mr. A. J. Smith, Division of Entomology, South Africa, has accumulated some preliminary unpublished data on these points at Rustenburg. Following discussions with Mr. Smith, copper wire gauze cages 4 ft. by 4 ft. (the gift of Messrs. Kynochs, Ltd., Umbogintwini, Natal) were set out in the experimental plots. Into these were introduced some hundreds of Sudan bollworm pupæ, commencing in April, with a view to obtaining the times and percentages of moth emergence under local conditions.

The initial consignment of pupated larvæ was supplemented by some hundreds of larva-invaded bolls, as newly emerged moths were frequently found in May. Prior to the addition of fresh numbers an examination was made of the condition of the pupæ already *in situ*. None of these were found to be unaffected by (a) moth emergence; (b) internal parasites; (c) damage by soil enemies or other causes.

The percentages of such were found to be, for (a) 63 per cent., and for the remainder 37 per cent.

An examination of the cages disclosed that moths could readily escape. Suitable precautions were then taken. No moth emergence was observed from June 5 until August 26. It is interesting to note the rise in soil temperature at this time.

As already reported, the last week in August revealed a fresh infestation of newly formed larvæ on the trap rows.

Consideration of the full data from these cages will not be possible for some months; meanwhile the progress of infestation of the trap rows is under critical observation.

Bollworm Trap Crops.—The trapping scheme is as follows. Certain rows of cotton have been left over from the past season. Adjacent to these are equal numbers of rows of (a) cotton ratooned to the first node; (b) cotton ratooned to 8 to 10 inches; and (c) cotton severely top pruned.

The standover rows are now bearing fair quantities of flower buds. It is proposed to remove these by hand (cattle pasturing has proved a most effective defoliator) when the conditions of infestation and age of the larvæ warrant doing so. It is proposed to deal similarly with successive infestations up to the point when the annually planted cotton provides an abundant food supply for the bollworm. It is expected that the variously treated ratoon strips will play an important rôle in providing feeding areas before the annually planted cotton is attacked. There should be a succession of feeding areas on the trap strips until November. The value of the procedure will rest largely on the percentage emergence of the moths in the intervening time.

It may be remarked that the old cotton has been disposed of at least two months earlier than has been the usual practice. Winter ploughing has been found quite practicable on most lands, and it is believed, partly from observation, that the consequent exposure of many bollworm pupæ has resulted in reducing the total of potential moths.

Leaf-eating Beetle, Syagrus rugifrons, Baly.—Some notes on this Chrysomelid Beetle have been contributed to the literature by G. C. Haines, Division of Entomology, South Africa. The minutes of a meeting of the Plant Pests Board in Uganda on October 5, 1925,³ refer to damage to young cotton plants by a white grub believed to be the larva of *Syagrus calcaratus*, Fabr.

The beetle (*S. rugifrons*) has been found associated with a small white grub. This beetle has been bred from the larva here.

In certain fields the feeding of the beetle on seedling cotton has destroyed 60 per cent. of the stand. Later the larvæ have been found attacking the roots of young and old cotton plants. The larval attack is generally fatal to the plant.

So far it is only on certain lands that congregations of the beetle assemble. It has been found, however, in small numbers throughout the whole area, and exists, according to report, in the Zululand cotton tracts.

The history of its appearance, spread, and damage to cotton was sufficient to warrant investigation of control measures. Pending observations on life history, trials of a range of contact and stomach poisons were planned. Prior to the receipt of the materials (which were procured by the Candover Estates, Ltd.), the practical disappearance of the beetle occurred in late December, and the experiments, as planned, had to be abandoned for that season. In February appreciable numbers were found on late germinating seedlings on some plots. Rows of these were dusted with commercial mixtures of Urania green (stated to be an improved Paris green), calcium arsenate, acid lead arsenate, potassium silico-fluoride, and nicotine dust. A combination of lead arsenate and Bordeaux mixture was sprayed on.

With the exception of potassium silico-fluoride, nicotine dust, and, less so, the Bordeaux-arsenate combination, the above was found effective to the extent that only dead beetles were recovered on the day following the applications. Independently of these trials a grower in the district had dusted beetle-infected patches of his fields with Paris green and reported complete success.

The potassium silico-fluoride tended to "lump up" in the blower, and did not suspend well on the leaves. The size of the particles appeared to be too coarse. Marcovitch⁴ reports good results with sodium silico-fluoride as an insecticide for the Boll Weevil, but remarks that the disadvantage of the commercial product is its density. Nicotine dust was of no value.

The day following the application of the Paris green a light shower fell, and subsequently drastic burning of the foliage was evident. This could probably be counteracted by increasing the proportion of calcium oxide; however, it is felt that the cost of the green is prohibitive for wide application.

The original experimental programme provided a consideration of the total costs of application for the insecticide employed. This could not be done efficiently with the programme which had to be substituted. Prices deduced from figures supplied by the manufacturers would indicate a cost of 10s. for two applications of calcium arsenate per acre, and 4s. to 5s. for two applications of lead arsenate, both dusted. A 1 per cent. Urania green mixture sells for £130 per ton. It cannot be said definitely that lead arsenate is equally as effective as the higher-priced arsenicals. If it proves to be so, no doubt it will be applied commonly. Magnesium arsenate did not arrive in time to receive a trial. According to report, it has high killing power for certain insects, and is cheaper.

The larva of the beetle is white, with a light to dark brown head, and is $\frac{1}{2}$ to $\frac{5}{8}$ inch in length when full grown. It forms a smooth-walled earthen cell, in which the larva metamorphoses to the beetle in the naked state. This stage appears to occupy three weeks.

The adult is about $\frac{2}{3}$ inch in length, ovoid, and of a black colour, with frequently a light bronze tinge. The beetle has not been found damaging older cotton plants to any extent. Its activities as a leaf feeder on the older plants is limited, but it has been found eating out shallow circular patches on the wall of the boll.

Present observations indicate that the beetle winters over as the adult. It is found in newly ploughed lands in July and August. In the light of the knowledge possessed at present it is proposed that, on its appearance on seedling cotton, calcium arsenate should be dusted over the infested fields.

The beetle feeds to a limited extent on *Abutilon soneratianum*, which is reported as a food plant of the Spiny Bollworm, and which also has been found to breed the cotton red spider *Tetranychus* sp., which has caused minor damage in the past season.

Jassid (*Chlorita fascialis*, *Jacobi*).—This Jassid fly appeared in small numbers on cotton in February. At no period in the ensuing months did it assume large numbers, and plant distress associated with it was barely discernible except on a block of cotton growing on a light sandy soil. It was there noted that groups of comparatively healthy green plants appeared at different points, and investigation proved these to be situated on old ant heaps, or where a large tree had been taken off.

Growers in Zululand report considerable loss from Jassid attack in the latter part of the season.

In March the Corporation's officers met at Barberton to see the Jassid-resistant strains selected by Mr. Parnell, and to make arrangements for their multiplication and, in general, to discuss various aspects of the work. The opportunity was greatly welcomed, and proved helpful and stimulating.

Cotton Stainers.—Stainers were not abundant until March, *Orycaenus* sp. appeared in enormous numbers in February, and remained during picking. *Nezara viridula* was commonly found from March onwards.

The volume of stained cotton increased steadily from March, and the later pickings suffered heavily. An analysis of the grading returns shows a complete shift of the chart into the badly yellow-spotted and stained grades as the season advanced. In the earlier pickings a few growers who made a point of separating brash and

spotted cotton from the clean material received higher prices, but this was impracticable later as the difficulty of disposing of the stained material was great. On the whole, no effort to effect separation of clean and dirty cotton was made at any time beyond minor control of the field pickers. Just how far it may be profitable to separate the seed cotton is a matter for the individual grower to decide by experiment. This would apply to the various pickings also. It would at least appear that careful classification of ginning lots is necessary.

Internal boll disease took heavy toll of late fruiting bolls in the Pongola Poort area.

The seed recommended for sowing has been secured from second picking material. This escaped the influence of the drought, or the worst of it, and arose before the stainer became most abundant. Germination tests carried out for many growers provided a 75 per cent. germination for the greater part.

Irregularities in Fields of Seedling Cotton.—Last spring gaps in rows and scattered germination generally were evident in most fields. An attempt to assess the causes was made.

The ordinary field cricket *Gryllus* was probably held responsible for the replanting of approximately 1,000 acres. On investigation it would appear that other factors had not been duly weighed. Where the seed bed had been properly prepared and clods broken, the seedlings came away fairly quickly where moisture was available, and on attaining some stiffening of the stem the cricket was resisted and, if damaged, the plant frequently pulled through.

Seed in many places had obviously been planted too deeply, and in consequence the seed food reserves were nearly exhausted before the cotyledons emerged. The surface of the soil being caked, the urge of the residual food-supply was unavailing in rupturing the crust, and only served to fracture the stem below the seed leaves, and the latter died or were eaten by crickets. Much of the deep planting was caused by "boys" riding the planter over soft ground. Too little seed per acre was planted out in several cases. Special thin-flow planters were used in one area which reported the heaviest loss from crickets. This, combined with the low germination percentage of the seed used from the wet season's crop (which suffered badly from stainer damage), gave little hope of a stand. Planters which had not been carefully inspected were not functioning properly, in that the gear spring had lost its elastic recoil and failed to engage the gear-seed drum systems, consequently for yards at a time no seed was being dropped.

In connection with poor seed Marsh⁵ has reported the occurrence of disease associated with stainer damage in samples of diseased seed cotton sent from Nyasaland. An examination of seeds from the 1925 crop, stored for seeding, showed 15 per cent. of these to be in a condition such as described by Marsh. Probably the internal boll disease of that season had given rise to *Nematospora* infection of a percentage of the seed.

Wire Worm and Cut Worm levied some toll. The Wire Worm does not appear to be the so-called Cotton Wire Worm (*Horistonotus uhleri*). To these depredations must be added those of *Syagrus rugifrons*.

The preparation of the soil for the coming crop is generally much better, and has the advantage of a two months' start in ploughing.

COTTON STALK CUTTERS AND OTHER IMPLEMENTS.

After considerable enquiry (with contradictory responses) from individuals and departments in the United States, it was decided to import different makes of the cotton cutting and shredding implements in use there. The advantage of these appeared to be their capacity for delivering the bushes in cut lengths of 10 inches or so, whereby the material could be returned to the soil without impeding subsequent soil preparation. Two of these implements were secured and given a trial in July, with disappointing results. They were of some value in cutting off small stands—*i.e.*, immature plants—but not sufficiently effective in dealing with large growth, especially if the plants were old and dried. The principle of operation depends on the revolving blades coming heavily in contact with the soil. Over stony ground the blades would readily be broken. Over uneven ground the cutting was very varied. As a time-saving device they leave much to be desired, and, apart from the value of returns to the soil, rapid destruction of the stand was a main point for consideration.

Modified mowing machines have been of limited use. Where oxen are employed for ploughing, etc., the stalk stubble is a frequent cause of laming, and the mowing method has not found favour. Various devices have been tried, but the implement sought must prepare the growth in a condition suitable for return to the soil without hindering tillage, or it must be quicker than hand hoeing, the usual method, if it does not so prepare the cotton bushes. An average labourer will cut about 6,000 yards per day on task work; 8,000 yards is not uncommon.

Anti-clog cross-row weeders have been introduced into the area during the past year, and have found favour in mulching and weeding in the row. Conservation of moisture is of first importance under local rainfall conditions.

SEED MULTIPLICATION.

Bulk Z.1 seed from the primary selections made by Mr. Parnell will be multiplied on freshly prepared blocks of land, covering between 200 and 300 acres. In addition to this seed, various lots from single-plant selections will be multiplied on new land in readiness, adjacent to the newly constituted experimental station. Selections from Cambodia and other local selections will be grown on the experimental station. The subsequent distribution of the multiplied seed has been tentatively arranged, and a portion will be placed in certain Zululand areas.

EXPERIMENTAL STATION.

A site covering 70 acres has been secured, and is now prepared, on which a series of experiments will be set out under critical control. The appointment of Mr. Keatinge as an Assistant on the station will no doubt greatly increase the scope of the investigations, as a division of the supervision and other work will now be possible.

The programme includes trials, which are badly needed, of various other crops, with a view to determining rotation schemes and soiling crops.

At the present time the land is fenced, and a central office-storage shed has been constructed. Housing provision for resident native labour is in progress. A *rondovel* and other necessary buildings are in course of construction for an assistant's quarters. The nearest suitable eminence, two miles distant from the plots, has been chosen as a building site. The *rondovel* is commodious and built of stone, quantities of good cutting stone having been found a few yards from the site. These buildings should be ready for occupation during the first week of October.

TRANSPORT.

During the past year transport conditions in the district have been greatly improved. The railway line is now open under normal traffic conditions as far as Candover Station, this being twenty-five miles distant from Magut. Formerly it was necessary to haul loads by ox transport over steep, hilly country eighty miles to a shipping point. Recently the railway authorities have mooted the provision of a

trucking service from Candover Station which will embrace tri-weekly journeys to all the neighbouring farms at normal railway freight and passenger rates. At the present time the road bed for the extension of the Pongola Poort-Matubatuba Line to the Pongola River is practically complete. Preparations for the construction of a combined rail and road traffic bridge over the Pongola River are in progress. This will give access to Swaziland, and incidentally permit closer co-operation between the Corporation's officers. A road bridge over the Pongola River connecting the cotton estates of the Transvaal corridor and Southern Swaziland with ginnery facilities at Magut was projected for the coming season, but its building has been postponed.

A rainfall of $\frac{1}{2}$ inch is sufficient to halt transport locally. It would be more correct to say that it has hitherto been sufficient to do so, for during the dry winter road parties have repaired the bog holes to a great extent, and vehicles may travel in most weather.

The Government are engaged in erecting a telephone system which connects the farms of the Magut district and farther afield.

CROP RETURN.

Six million pounds of seed cotton have been produced in the Magut-Pongola Poort area during the past season, about 4,000 bales (500 lbs. each) of lint.

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SWAZILAND

INTRODUCTORY NOTE BY MR. S. MILLIGAN.

MR. WOOD'S Annual Report which follows consists mainly of a record of the Experimental Station at Bremersdorp, and of the plot experiments conducted at various other centres in Swaziland. It, however, conveys an inadequate impression of the year's work: Mr. Wood arrived in Swaziland about the middle of September, a month before the normal planting season for cotton; he had neither buildings nor prepared land, but in spite of everything he succeeded in establishing not only a headquarters station for his main experimental work, but a chain of substations in representative tracts, in time for the coming season. This in itself entailed a large amount of work even for an experienced organizer. Mr. Wood received every assistance from the resident Commissioner and his staff, and the Swaziland farmers readily co-operated.

In drawing out a programme of investigation two main considerations had to be borne in mind: (1) The very considerable diversity of local conditions as to both soil and climate; (2) the absence of any records other than meteorological data.

It was obvious, therefore, that Mr. Wood would have to begin at the beginning; the best planting seasons would have to be worked out separately for each tract, optimum spacings would have to be investigated, the most suitable types of plants discovered, and injurious insects would have to be carefully watched.

Swaziland does not offer the same facilities as are to be found at, say, Candover; cultivation is more scattered, and field comparisons, which form a feature of the latter area, are difficult, if not impossible, in the former. A chain of substations, each with its own series of field experimental plots, is therefore essential to the work in Swaziland. Mr. Wood's report is a record of first-season results, so, probably, the less comment on the figures the better, except possibly to remark on the absence of contradictory evidence in the spacing and time-of-sowing results. Persevered with, and possibly improved on in the light of experience, the experiments show every indication of valuable information being forthcoming in the course of a few years. The principle of studying the crop, its diseases and pests, under varied farming conditions will, I think, prove to be sound.

REPORT ON EXPERIMENTAL WORK ON COTTON IN SWAZILAND—SEASON 1925-26

BY

R. CECIL WOOD.

Most of the experimental work was carried out at Bremersdorp, the headquarters of the Cotton Specialist, but experiments were arranged at other places by the kind co-operation of the farmers concerned. These will be found discussed along with similar experiments conducted at Bremersdorp.

The full programme at headquarters included spacing and time of planting experiments, a test to estimate the value of kraal manure for cotton, and a series of variety tests, under standard conditions, to compare with similar experiments that were being conducted in other parts of South Africa. Trials were made of other crops which it was thought might be useful as rotation crops for cotton. Attention was given to the work of selecting high quality, jassid-resistant strains for propagation in Swaziland. These different lines are treated in detail below.

Bremersdorp is situated in what may be described as the middle veldt, and is about 2,000 feet in elevation, with a mean temperature of 72° F. in summer and 62° F. in winter, and an average rainfall of about 38 inches. It is probably just at the upper limit for cotton-growing, and most of the cotton area lies below, and to the north, east, and south of it.

Land for the experiments was put at my disposal by Mr. Coates, to whom the Corporation are indebted for the assistance which he has always been willing to give, and which, in view of the fact that work was being initiated in a new area, was most welcome. The site of the plots was on somewhat undulating land—it was found impossible to get a large area of level land in the neighbourhood—and was a red loam soil, resting on a dyke of dolerite in the general granitic formation of the country. It was found to be extremely irregular, but, fortunately, as the plots were all repeated four times, it has been possible to draw some results from them.

SPACING EXPERIMENTS.

1. BREMERSDORP.—Twelve plots, each 12 by 20 yards (one-twentieth of an acre), were planted to test three spacings—1 foot, 2 feet, and 3 feet respectively—each spacing being repeated four

times. The plots were laid out in two rows, and the drills were spaced evenly and continuously, 1 yard apart, throughout the series, the only variant being the distance in the drills. The plots were sown by hand with seed of the variety Griffin at the exact distances required, a small handful of seed being sown at each spot. Sowing was done on November 25, the first thinning, when the plants were sixteen days old, on December 11, and the second thinning on December 29. The land appeared at this time to be fairly uniform, but this proved not to be the case, and very serious inequalities made themselves evident at an early stage. Weekly pickings were made, and the full weights are recorded on p. 66.

There was a slight wash across the plots which, fortunately, owing to the dry season, did not become very serious. The plot most affected was 1A; plots 2A and 3A were affected, but to a smaller extent. This was noted early in the season, but the main differences were not seen or noted until rather later, when the plants were some seventy days old. A few blanks occurred, but that the spacing was fairly accurate will be evident from counts made in the fourth and eighth row of each plot:

		1-Foot Spacing.	2-Feet Spacing.	3-Feet Spacing.
Number of plants in 60-foot row	A	52	28	19
		55	30	19
	B	57	29	20
		58	26	18
	C	60	27	19
		60	26	18
	D	57	30	18
		59	29	15
Mean		57	28	18
Mean distance between plants in inches		12.6	25.7	40.0
Square inches per plant ..		450	918	1,440

Jassid attacked the plots in March, but made very slow progress until the middle of April, when all the plots were noted as showing the effect of this pest pretty badly. No difference was discernible between the plots as regards their resistance or susceptibility; the attack came from one side and gradually spread across. The damage seemed to show up worst in the widely-spaced plots, but this was possibly due to the fact that the plants were more isolated, and

showed up more when really badly affected. Plots 1C and 2C seemed to get over the attack most quickly, and on May 15 they were putting out new leaf; some of the other plots were completely finished.

SPACING EXPERIMENT—PLOTS (ONE-TWENTIETH ACRE).

Date.	1 Foot.								2 Feet.								3 Feet.							
	1A.		1B.		1C.		1D.		2A.		2B.		2C.		2D.		3A.		3B.		3C.		3D.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
March 30	—	2	—	12	4	4	—	12	—	7	—	4	2	3	—	3	—	4	—	5	1	7	—	4
April 9	1	5	3	3	18	8	1	15	2	0	2	0	3	15	1	4	1	8	1	10	3	15	1	0
„ 15	1	9	3	3	19	2	2	11	2	12	2	10	5	5	2	0	2	6	2	7	5	3	2	2
„ 22	1	14	4	5	2	4	4	13	3	2	3	11	8	4	2	7	3	4	4	1	8	6	3	9
„ 29	3	2	5	12	1	13	7	2	4	4	4	7	10	4	3	6	3	6	4	5	9	6	4	9
May 6	3	10	4	14	3	12	6	14	6	9	3	5	6	8	3	4	2	10	3	1	5	8	3	1
„ 13	3	14	5	6	3	13	6	4	3	14	5	3	6	12	4	15	4	4	5	0	5	11	4	11
„ 20	2	6	2	3	1	10	2	1	1	15	2	2	2	15	2	4	1	11	2	5	2	11	2	8
„ 27	—	14	—	13	—	14	1	8	—	14	1	3	1	11	1	3	—	11	1	10	2	0	1	9
June 3	—	8	—	6	—	14	—	6	—	8	—	12	—	8	—	6	—	4	1	3	—	11	—	15
„ 10	—	2	—	8	1	0	—	1	—	3	6	2	5	—	11	—	4	1	0	—	10	—	7	
Total ..	19	6	31	5	57	14	34	10	26	8	25	15	50	10	21	15	20	8	26	15	45	8	24	11
Meanlbs. per acre	716								625								588							

The records of picking show that the closer spacing has resulted in hastening the maturity of the plants, and that the later growth of the wider plots did not make up for, though it reduced, the superiority early established by the 1-foot plots. Daily counts of the flowers produced in each plot were taken, but did not start early enough in the season, but from the middle of February, intermittently, and from March 1, regularly, the flowers in two rows of each plot were recorded daily. At the start, flower production on the closest planted plot was very much in excess of the other two, being at the rate of about 600 flowers, while the 2-foot plots were producing about 375, and the 3-foot plots only about 255 flowers per plot per day. At the end of February, ninety-five days after planting, there was a very sudden cessation of flowering on all the plots, pro-

duction being a little over 150 for all spacings. Thereafter flowering on all plots was remarkably uniform, with ups and downs, which affected all spacings equally, the 3 feet being slightly the best, and the 1 foot slightly the worst, until about 130 days after planting all flowering practically ceased and no more flowers were produced to the end of the season. Picking started 125 days after planting, and finished 197 days after planting.

2. NATALIA RANCH HEADQUARTERS.—This station is situated in the low veld, and is considerably hotter and drier than Bremersdorp. The elevation is about 700 feet, and the rainfall averages only 25 inches a year. The mean summer and winter temperatures are 79° and 62° respectively; temperatures of over 100° are common in the summer. The work was kindly carried out by Captain Miller.

The season was unfortunate, and, though the plots were all carefully sown, the ground was not moist enough to ensure an even germination. An inspection of the plots before thinning was done made it clear that it would not be possible to obtain even an approximation to the stand required, and there was no choice but to discard them.

3. MBULUZAN.—This experiment was conducted on land belonging to Mrs. Scott, and the work was kindly undertaken by Messrs. Weeks and Woodcock, who devoted a good deal of their time to the efficient carrying out of the scheme. Mbuluzan is situated in the lower middle veld close to the Umbelusi River; the field in which the plots were situated sloped gradually and uniformly, and the twelve plots were laid out in a long strip running down the slope. The soil was a light, pinky grey sand, of granitic origin, and in spite of the season has shown itself remarkably capable of supplying moisture for the needs of the crop. Germination in all cases was good: the plots were planted out on December 5, along strings as at Bremersdorp, and subsequently thinned. The plots were picked twice, on May 10 to 12 and June 5, and gave the following weights:

PLOTS ONE-TWENTIETH OF AN ACRE.

Yield per plot	Series 1 (1 Foot).				Series 2 (2 Feet).				Series 3 (3 Feet).			
	1A.	1B.	1C.	[1D].	2A.	2B.	2C.	[2D].	3A.	3B.	3C.	[3D].
	lb. oz. 10 12	lb. oz. 11 15	lb. oz. 11 10	lb. oz. [5 13]	lb. oz. 10 8	lb. oz. 9 13	lb. oz. 8 14	lb. oz. [2 9]	lb. oz. 3 6	lb. oz. 3 8	lb. oz. 3 0	lb. oz. [1 15]
Average per acre for 3 plots	229 lbs.				195 lbs.				66 lbs.			

The experiment may, with the omission of the D plots, be taken as a perfectly fair one. These were the lowest plots at the bottom of the strip, and, though the land appeared uniform, it is obvious that they have suffered from their position, and their yields are consequently disregarded in working out the average. The plots next above them are 3C and then 2C, both of which show a slight reduction as compared with the others. With these exceptions, however, the plots seem to be remarkably uniform and the figures are considered reliable.

As in Bremersdorp, the closest planting, 1 foot, with rows 1 yard apart, has given the highest yield.

During the pickings, the clean cotton was kept apart from the stained cotton, and the weights were recorded separately; in the two more closely planted plots the proportion seemed about the same, the actual acre yields of clean cotton are for the 1-foot plots 158 lbs., and for the 2-feet plots 139 lbs., a smaller difference than that shown above. In the 3-feet plots the proportion of stained cotton was very much less; in two cases, indeed, no stained cotton was picked at all. Evidently these more isolated plants were less invaded by the stainers than the plants which stood close to each other, and afforded shelter and an easy passage. The point will be borne in mind and watched during the coming season.

4. WISSELRODE.—This farm is situated in the Lebombo Flats, at an elevation only a few feet above sea-level. The land was kindly placed at my disposal by Mr. von Wissel, who modified the original scheme by introducing an 18-inch spacing, and by manuring half the plots with superphosphate. Owing to the dry season, this manure seems to have had very little effect, and for purposes of comparison between different spacing it may be ignored. The table below gives the figures obtained:

LOTS ONE-TWENTIETH OF AN ACRE.

<i>Spacing.</i>				1 Foot.	1½ Feet.	2 Feet.	3 Feet.
				lb. oz.	lb. oz.	lb. oz.	lb. oz.
A	..	..	..	18 5	30 12	23 5	23 12
B	..	..	..	31 9	20 1	24 8	25 3
C	..	..	..	33 2	13 4	23 15	25 13
D	..	..	..	25 5	15 11	33 2	20 14
Total				108 5	79 12	104 14	95 0
Mean				27 1	17 15	26 3	23 12
Per acre ..				541 lbs.	400 lbs.	524 lbs.	475 lbs.

The outside plots suffered some damage, partly from grasshoppers, at the upper end, while the lower end seems to have included some shallower soil on which the land was observed to be cracking during a spell of dry weather. Thus, allowances should be made for plot 1A, 1.5B, 1.5C, and 1.5D. The 2-foot plots undoubtedly, and the 3-foot plots probably, were favoured by their situation, and there seems no reason to doubt that, as in other similar experiments, the closest planted plots have really given the best results. The yields have been quite good, and the plots kept remarkably free from damage by insects throughout.

5. INGWAUVUMA.—This station is also on the flats, and the experiment was carried out by the assistance of Messrs. Cotton Plantations, Ltd., the owners of the land. Unfortunately the Company had not started work for very long, and facilities for experimental work were not available, so that both this and the time-of-planting experiment at this station suffered to some extent. The variety used was Improved Bancroft. The experiment was conducted on lines similar to those at headquarters, and the results are given below.

The yields have been low throughout, and much reliance cannot be placed on the figures. The plots were unfenced and suffered damage from stray animals that grazed thereon, while the site selected was unsuitable. A certain amount of boll-shedding was noticed towards the end of the season.

PLOTS ONE-TWENTIETH OF AN ACRE.

<i>Spacing.</i>					<i>1 Foot.</i>	<i>2 Feet.</i>	<i>3 Feet.</i>
					lb. oz.	lb. oz.	lb. oz.
A ..	..	..	..	..	5 10	4 12	8 6
B ..	..	..	..	..	5 10	4 12	5 12
C ..	..	..	..	..	6 8	5 2	4 4
D ..	..	..	..	..	6 8	10 1	6 11
Total ..	..	..	..	..	24 4	24 11	25 1
Mean ..	..	..	..	..	6 0	6 5	6 4
Per acre	..	..	..	..	121 lbs.	126 lbs.	125 lbs.

Spacing experiments were also carried out by Mr. Parry at Matindeli on the White Umbelusi, but suffered so severely from drought that they came to nothing. The same may be said of the plots laid out by Mr. Boast on his farm on the Lebombo Flats, south of the Ingwavuma; imperfect germination necessitated resowing,

which made the plots too late to be of any use. Plots were also laid out by the Messrs. Black on the Usutu, but unfortunately, through a misunderstanding, they were wrongly planted. The thanks of the Corporation are due to all those who helped in this way.

TIME-OF-PLANTING EXPERIMENTS.

1. BREMERSDORP.—The plots were laid with the view of watching the results of planting at six fortnightly intervals. It was not possible to start them earlier than November 1, and the last plot went in on January 15; this period is on the late side, and it will probably be better in the coming season to start on October 1, and plant till the end of December, for it seems likely that for cotton planted after this date the weather becomes too cold towards the end of its growing period. The plots were all laid out in quadruplicate, and were $\frac{1}{20}$ acre in extent, and were situated on what appeared to be a uniform belt of red soil, with a slight fall towards the south-east. Unfortunately serious differences soon began to make themselves evident in plots treated similarly, and, as will be seen from the figures, the land has proved most uneven. It is almost impossible to get any level stretch of a reasonable size in this area, which is in very undulating country.

The plots were picked weekly; the results are abstracted below:

			<i>Series 1</i> (Planted Nov. 1).		<i>Series 2</i> (Planted Nov. 15).		<i>Series 3</i> (Planted Dec. 1).		<i>Series 4</i> (Planted Dec. 15).		<i>Series 5</i> (Planted Jan. 1).		<i>Series 6</i> (Planted Jan. 15).	
			lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
A	..	..	24	14	16	10	13	11	18	5	7	13	0	4
B	..	..	36	12	14	12	23	12	42	14	5	6	0	2
C	..	..	42	6	18	4	19	9	21	11	7	1	0	3
D	..	..	49	13	16	10	21	13	25	1	10	15	0	8
Total ..			153	13	66	4	78	13	107	15	31	3	1	2
Mean per plot ..			38	7	16	9	19	11	26	15	7	13	0	4
Mean per acre ..			768 lbs.		331 lbs.		394 lbs.		538 lbs.		156 lbs.		5 lbs.	

The significance of these results can only be interpreted in the light of the observations made during their growth. Generally speaking, the plots show an improvement diagonally across the area, 1A at the north-east corner of the plots being very much

inferior to the other plots planted on November 1, and 1D at the south-west corner being superior: this plot, it may be noted, produced at the rate of nearly 1,000 lbs. of seed cotton to the acre. This effect is shown uniformly with the single exception of 3C (a December 1 plot), which, though favourably situated next to 1D, has not done remarkably well; it was, however, noted on more than one inspection as being "gappy," and, as will be seen later, all this series had rather an unfortunate time in becoming established. Germination was, however, particularly bad in series 2, planted on November 15; although 2·30 inches of rain fell on November 11, there was almost a complete drought from then until a good fall on December 17. The result was that though there was enough moisture to prevent the seed lying dormant, as was the case with the plot sown on December 1, there was not enough to produce a full stand. Counts made showed an average of only 22 plants to the row, as against 52 in series 1, 43 in series 3, and 50 in series 4. In ordinary farming practice the plots would have been resown. The case of series 3 is rather different: the soil appeared thoroughly dry, and no germination was visible until after the rain on December 17, which means that these plots came up at the same time as those in series 4, which were sown on December 15. They never did so well; the inferiority, although slight, is perfectly definite, and is shown in each pair, and presumably the seeds must have absorbed some moisture. The later plots, series 5 and 6, may be dismissed by saying that for this season they were too late, and never at any time looked like giving a crop.

Jassid appeared in the plots towards the end of February, but did not become severe until April had set in. Aphis bothered the crop at intervals: it probably intensified slightly the difference between the good and the bad plots.

As in the case of the spacing plots, a record was kept of the daily flower production, though unfortunately not from a sufficiently early period in the life of the earliest plots. The curves when plotted out show in a most remarkable way the definite and sometimes abrupt termination of flowering about the 120th day after sowing. This was very marked in the case of the plants in series 1 and series 3 and 4; series 5 never produced very many flowers, so the drop is not so marked. Series 2 produces a curve more like the wide-spaced plots in the spacing experiments, for it had a very bad stand, and such plants as there were all had ample space. Consequently, its flowering period was more continuous and longer-drawn-out. It is noteworthy, too, that there was no sign of further

flower production after the main first flush had finished, except perhaps to a slight extent in series 1, but this was due to plot 1A, which, as has been remarked, started very slowly and was very backward throughout. The tables below will show the dates of flowering and bolting as far as has been determined:

FLOWERING.

	Start.		Finish.		Period in Days.
	Date.	Days Old.	Date.	Days Old.	
Series 1 (Nov. 3).. ..	—	—	Feb. 28	120	—
Series 2 (Nov. 15)	—	—	Apr. 12	148	—
Series 3 and 4 (Dec. 15) ..	Feb. 20	55	Apr. 14	120	65
Series 5 (Jan. 1)	Mar. 3	63	May 1	122	59
Series 6 (Jan. 15)	Mar. 23	66	—	—	—

BOLLING.

	Start.		Finish.		Period in Days.
	Date.	Days Old.	Date.	Days Old.	
Series 1 (Nov. 3).. ..	Mar. 13	133	May 14	196	63
Series 2 (Nov. 15)	Apr. 16	153	June 19	225	72
Series 3 and 4 (Dec. 15) ..	Apr. 23	128	June 18	195	67
Series 5 (Jan. 1)	May 14	135	June 25	190	55
Series 6 (Jan. 15)	—	—	—	—	—

They are of interest in view of the regulations which have been introduced to enforce a closed season, for they show that *in this season* a period of seven months (212 days) would have been ample for any normally planted crop, and that a two-months' close period would still give the farmer three months in which to vary his dates of cropping.

2. NATALIA RANCH: HEADQUARTERS.—The plots were laid out in two rows, and were situated on a fairly dark turfy soil. The season was an extremely hot and dry one, and the plots suffered severely from uneven germination which largely spoilt the results. The earliest plot was put in on October 3, and thereafter at seven fortnightly intervals till January 15. Each planting was replicated four times. The results are as follows:

PLOTS ONE-TWENTY-SECOND OF AN ACRE.

	Series 1 (Planted Oct. 3).	Series 2 (Planted Oct. 15).	Series 3 (Planted Nov. 1).	Series 4 (Planted Nov. 15).	Series 5 (Planted Dec. 1).	Series 6 (Planted Dec. 15).	Series 7 (Planted Jan. 1).	Series 8 (Planted Jan. 15).
A ..	lb. oz. 4 10	lb. oz. 4 6	lb. oz. 2 15	—	—	lb. oz. 3 13	lb. oz. 4 14	—
B ..	6 11	4 6	2 9	—	—	2 13	5 4	—
C ..	4 15	6 12	5 4	—	—	1 2	2 12	—
D ..	8 6	10 2	4 10	—	—	11 3	4 7	—
Mean per acre }	135 lbs.	141 lbs.	84 lbs.	—	—	104 lbs.	95 lbs.	—

The following observations may be made about the plots. The first-planted plots were exceedingly slow in germination, and were only a day or two before the second series, though never quite so good, and this corroborates experience at Bremersdorp, where the seed in the plot with delayed germination, though to all appearance it remained quite dormant, had yet in some way deteriorated. The third series, November 1, is disappointing, but it is reported to have suffered severely from the very hot and dry weather towards the end of the month. A caterpillar attack was recorded on November 20. The next series suffered the same fate as at Bremersdorp and practically failed. Much the same is the case with the December 1 plantings: the rain that at Bremersdorp brought these up on the 17th was not received here, and both this and the next planting did not germinate until December 28. There is thus not very much difference between series 6 and series 7 except that series 6 was very gappy, and therefore had fewer plants than series 7; had both plots been equally filled, the superiority of the earlier plots would have been more marked. There was little insect attack throughout the period, and Jassid did no harm.

The general conclusion that may be drawn from the experiment is that, *as far as this season is concerned*, planting in late October, after the rainfall of 1·28 inches on the 22nd, would have offered the best chance of success. Against this, there is the evidence of the plots which were sown on November 1, which suffered severely from the heat towards the end of November and December. It is possible that the seeds which germinated on the 19th were just strong enough to stand this heat. After this, there was no chance to sow until after the rains on December 31, for the small quantity of rain that was received in November and early December fell in

very slight showers and was of little use: this is too late to obtain a full crop, and the intense heat of January affected the plants and made these plots rather sparse; the last-planted plots, series 8, were a complete failure.

The season was abnormal in that opportunities for successful planting only occurred before and after what is usually considered the best time—*i.e.*, November.

3. RED TIGER.—This is only 14 miles away from Natalia headquarters, but has received a very different rainfall, as will be seen from the diagram attached (Appendix), and a very different state of affairs was the result. The plants were very much more luxuriant, but suffered severely from Red Bollworm, which reduced their yields considerably.

The plots were laid out in two rows, on a dark chocolate loam soil. The actual quantities harvested from the plots are given below:

LOTS ONE-TWENTY-SECOND OF AN ACRE.

			Series 1 (Planted Oct. 16).	Series 2 (Planted Nov. 1).	Series 3 (Planted Nov. 16).	Series 4 (Planted Dec. 1).	Series 5 (Planted Dec. 15).	Series 6 (Planted Jan. 1).	Series 7 (Planted Jan. 15).
			lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.		
A	..	..	12 15	21 14	0 14	—	—	—	—
B	..	..	8 15	11 13	1 6	2 2	2 0	—	—
C	..	..	13 11	17 9	4 7	1 14	2 3	—	—
D	..	..	22 10	24 8	1 10	—	—	—	—
Mean per acre ..			320 lbs.	416 lbs.	46 lbs.	22 lbs.	23 lbs.	—	—

The first two series have done fairly well. They both germinated soon after sowing, and their rate of growth is noted as having been remarkably similar. Dry weather followed the sowing of series 3, and it did not germinate till December 3, and, as in all the other plots planted at this period, was always a gappy and irregular stand. The remainder of the plots have been failures, though some of them gave great promise. The plots sown on December 1 did not germinate till after the rain on the 17th, which brought up the series 5 plots quickly and strongly. These plots looked excellent, and as late as April 26, though shedding was noticed, a fair crop was anticipated. There was a good deal of Jassid, which must have caught these later plots, while boll-rot was present; but it is presumably the Red Bollworm which is responsible for the trouble, and this

indicates the risk of late sowing in areas where this insect is prevalent. Although it was hot, the rainfall was excellent in January, February, and March, and this may be the cause of the greater damage caused by insects as compared with Natalia headquarters.

4. MBULUZAN.—The plots were laid out in two rows, alongside the spacing plots already referred to, and were planted on the dates mentioned. The results from the plots are given below:

PLOTS ONE-TWENTIETH OF AN ACRE (FIGURES PER ACRE).

		<i>Series 1</i> (Planted Oct. 29).	<i>Series 2</i> (Planted Nov. 13).	<i>Series 3</i> (Planted Nov. 26).	<i>Series 4</i> (Planted Dec. 10).	<i>Series 5</i> (Planted Dec. 24).	<i>Series 6</i> (Planted Jan. 7).
		lb.	lb.	lb.	lb.	lb.	lb.
A		444	510	423	184	61	—
B		655	560	643	195	29	—
C		592	494	433	[126]	[—]	[—]
D		[450]	[419]	[278]	221	29	—
Mean		563	521	499	200	40	—

Seldom is it possible to record an experiment so completely regular and definite in its results, for the figures hardly need interpretation. The figures in brackets represent the six lowest plots in the series, which, just as in the spacing experiments, were definitely inferior to the rest, and have therefore not been included in calculating the mean. In all other respects, the figures may be taken as they stand, for there was remarkably little insect attack. Jassid appeared, but after the bulk of the crop had ripened.

The quality of the crop shows little difference as far as the different plantings are concerned. The first four plantings give 37, 36, 24, and 29 per cent. respectively of soiled cotton to the total quantity picked.

The earliest planting has in this experiment therefore been the most successful, though there is little difference between the first three plantings.

5. INGWAVUMA.—The experiment was on similar lines to those described above. Owing to a mistake, the first plots were only planted on November 21, and then only a duplicate planting was made: regular plantings replicated four times, started on December 1, and continued more or less regularly until January 18. Improved Bancroft was the variety of cotton sown. The yields are given on p. 76.

PLOTS ONE-TWENTIETH OF AN ACRE.

			<i>Series 1</i> (Planted Nov. 21).	<i>Series 2</i> (Planted Dec. 1).	<i>Series 3</i> (Planted Dec. 24).	<i>Series 4</i> (Planted Jan. 3).	<i>Series 5</i> (Planted Jan. 18).
			lb. oz.	lb. oz.	lb. oz.	lb. oz.	
A	..	..	8 11	10 13	5 0	3 14	—
B	..	..	12 3	12 0	3 6	6 13	—
C	..	..	—	9 6	7 0	8 1	—
D	..	..	—	9 5	5 4	4 8	—
Mean	..	..	10 7	10 6	5 2	5 13	—
Per acre	..		208 lbs.	207 lbs.	103 lbs.	116 lbs.	—

There is not much to be said about these figures. Germination was reported regular and even in all cases, though "Harvester Ants" did considerable damage to the young plants. The crop planted on December 1 did remarkably well, as compared with that at Natalia, only some thirty-five miles away, where plots planted on this date completely failed to germinate. The later planted plots looked very well up to the beginning of May, but failed to set any bolls.

MANURIAL EXPERIMENTS.

1. BREMERSDORP.—A simple series of eight plots was laid out to estimate the value of kraal manure for cotton. This substance naturally varies considerably in its composition. Since it is largely dung accumulated from animals kraaled, or confined in a small fenced area, without any litter, it may be extremely rich, but the sample used in this instance was desiccated and contained a good deal of soil. It was sifted before application at the rate of 2,000 lbs. to the acre. The application was made on November 23, the plots were lightly ploughed on the 25th, harrowed on the 26th, and sown on the 28th. The size of each plot sown was 14 yards by 22 yards, but the manure was applied to half the number of plots, in a space 12 yards by 20 yards, and subsequently, on April 15, when the plants were full grown, a strip 1 yard wide was cleared round each plot, leaving the manured areas only to be harvested. The pickings obtained from the plots are as follows:

PLOTS ONE-TWENTIETH OF AN ACRE.

<i>Unmanured.</i>					<i>Manured.</i>				
<i>Number.</i>			<i>Yield per Plot.</i>	<i>Yield per Acre.</i>	<i>Number.</i>			<i>Yield per Plot.</i>	<i>Yield per Acre.</i>
1A	..	..	lb. oz.	lb.	1B	..	..	lb. oz.	lb.
2A	..	..	26 0	520	2B	..	..	16 14	337
3A	..	..	32 8	650	3B	..	..	20 2	402
4A	..	..	20 4	405	4B	..	..	24 14	497
	..	..	20 0	400		..	..	16 0	320
Mean	..	..	—	494	Mean	..	..	—	389

Germination was very uneven. The slight shower just before planting was insufficient to bring the seedlings up, and only a few plants, mostly in the upper row of plots, came through. The rain on December 17 helped things, and by the end of the month the plots were considered fairly complete. No. 1B was unfortunately at the upper north-east corner, and is on thinner soil; it was noted as poor from the start. Apart from this plot, the evidence is considerably in favour of the unmanured plots, which is no doubt to be ascribed to the natural inequality of the land, coupled with the fact that the very dry weather has hardly given the manure a chance. The plots will be repeated next year on the same ground, and if the manure has become thoroughly incorporated with the soil, we may expect to find the natural superiority of the unmanured plots considerably reduced.

2. NATALIA RANCH HEADQUARTERS.—A similar eight-plot experiment was laid out to test the value of a dressing of superphosphate. It appeared doubtful whether, in view of the large holdings occupied by most farmers and the extensive nature of their cultivation, any expenditure on artificial manures was likely to be profitable. The plots were planted in December, and the odd numbers received superphosphate at the rate of 200 lbs. to the acre. The effect of the manure, as might have been expected in such a dry season, has been nil, as will be seen from the figures below:

PLOTS ONE-TWENTIETH OF AN ACRE.

<i>Manured.</i>					<i>Unmanured.</i>				
Plot 1	..	..	..	lb. oz.	Plot 2	..	..	..	lb. oz.
„ 3	..	..	..	7 10	„ 4	..	..	..	7 12
„ 5	..	..	..	8 2	„ 6	..	..	..	7 5
„ 7	..	..	..	6 7	„ 8	..	..	..	4 14
	..	..	..	2 6		..	..	..	5 2
Total	..	..	..	24 9	Total	..	..	..	25 1

Variety Trials.—Most of the ordinary varieties found in the country were grown on a small scale, for general observation and as affording material for seed selection. These included Improved Bancroft (obtained from Barberton), Griffin (local), Zululand Hybrid (from Candover estates), Watts' Long Staple (from Barberton), and Uganda (from Mr. Roux of Barberton, and from the Coal Mines). Though the results are not comparable, owing to the different times at which the varieties were planted, and the different soils they occupied, there is little doubt that for vigour and yield the best was Roux's Uganda. This occupied something under 3 acres, and yielded over 500 lbs. of seed cotton to the acre. Sown alongside on the same day, but on a poorer soil, Zululand Hybrid gave less than 200 lbs. to the acre. Griffin and Improved Bancroft were sown later and did worse: it is worth noting that one of the $\frac{1}{20}$ acre plots of Griffin sown early in November (No. 1C) gave just on 1,000 lbs. of seed cotton to the acre on unmanured land.

Standard Variety Test.—These varieties, along with the strain of Improved Bancroft issued from the Government station at Rustenburg and excluding Watts' Long Staple, were subjected to a closer comparison, in a series of twenty plots, in which each variety was repeated four times. The plots were four drills wide, with 3·5 feet between the drills in the plot, and 6 feet between the drills of adjacent plots, and were 100 yards long. For purpose of calculation, they may be taken as 500 yards square. As will be seen from the figures which are given below, the plots showed the same irregularities as appeared in the other experiments. The land sloped down the length of the plots, but the centre of the area was lower than the outside edges, and had evidently suffered from erosion: the centre plots never made much progress. The low yield of these plots is also due to an attack by the Lesser Mystery Worm (*Laphygma exigua*), which was only just prevented from completely destroying the young seedlings, which were putting out their second leaves. Many of the plants grew up bifurcated, and as the plots were none too early (sown December 21), such plants were too late to make much contribution to the total yield. The plots also suffered from Jassid.

The actual figures worked out per acre are as follows:

Variety.	Yield per Acre in Lbs.			
	1.	2.	3.	4.
Barberton Improved Bancroft	84	48	39	216
Rustenburg Improved Bancroft	82.5	28.8	21	294
Griffin	97.5	24	33	435
Zululand Hybrid	87	30	51	366
Uganda	105	57	144	561

In spite of the low yields, the superiority of the Uganda is fairly definite. In only one case does it fail to top the plots on either side of it, and that is in the case of the third replication, where it is inferior to the first plot of Barberton Improved Bancroft in the fourth series. This third plot of Uganda was noted as being very poor in the centre, and had, moreover, a large part of one line entirely missing. Notes taken in the early part of the season emphasize the strong vegetative growth of Uganda as compared with the others, so that it was possible to pick out the plots by sight in the field. This vigorous growth enabled the plant to make better recovery after the Mystery Worm attack was over. As will be seen later, it also suffered less from Jassid.

It is difficult to say much about the other varieties. Of the two Bancrofts, the Barberton seed was the better; the reverse result in the last series may be accounted for by a fertile patch which benefited RIB.4, and incidentally still more G.4, which shows up remarkably well. As far as Jassid is concerned, the Rustenburg seed proved most susceptible.

An attempt was made at intervals to estimate the extent to which the plots were affected by Jassid. Three counts were made and care was taken to avoid subjective error. The results are given below:

MARKS ALLOTTED FOR SUSCEPTIBILITY TO JASSID.

	First Count.	Second Count.	Third Count.
Barberton Improved Bancroft	1	2	3
Rustenburg Improved Bancroft	4	5	5
Griffin	5	4	4
Zululand Hybrid.. ..	3	3	2
Uganda	1	1	1

Uganda shows itself the most resistant; both Griffin and the Rustenburg seed proved extremely susceptible.

Besides the above comparison, four American varieties were grown to gauge their suitability to the district and to serve as possible

material for selection—Delfos, Cleveland, Webber 49, and Express. The plots were sown in mid-November, but as was noted in the account of the time-of-planting experiment, germination at this period was most uncertain. The plots were filled by hand on December 29, which was too late to do justice to the varieties. Express seemed the hardiest, and came away with the best original stand, and for some time was noted as the best plot. Delfos was the earliest; it was the first to be attacked by Jassid, and suffered the worst; it yielded 380 lbs. per acre of cotton of excellent quality. Cleveland never grew well; it showed a curious reaction to the attack of Jassid, as the leaves turned a very deep purple-red, but did not—generally speaking—show the characteristic curling of the leaf; it produced just over 300 lbs. per acre of a poor, short cotton. Webber 49 proved the best as far as quality and resistance to Jassid are concerned, and it produced at the rate of nearly 700 lbs. per acre off a $\frac{2}{10}$ acre plot. Though Express yielded more, 760 lbs., it is not of such good quality, though its earliness enabled it to get through before the Jassid became really serious. Webber 49 had a thorough testing with this insect, and proved remarkably resistant: it possesses a very nice compact habit, and is worth further trial, which will be given this season. A number of selections were made in this plot.

A small $\frac{2}{10}$ acre plot of Cambodia, from seed grown the previous year at Barberton, was sown along with the above American varieties. It grew in the most wonderful way after the initial difficulties of germination were surmounted, and many of the plants were over 6 feet high when mature. The plant was very brittle, and the branches continually broke, so that this plot was a perfect jungle towards the end of the season. It ripened very late, and the first picking was not till the end of May (200 days), though Express had given a heavy picking (300 lbs. per acre) on April 30. The total yield was 180 lbs. to the acre of medium quality cotton. A number of plants were noticed bearing flowers with a crimson spot at the base of the petal; they are possibly natural crosses with Pima, which was growing alongside the plot in the previous year at Barberton; some of them yielded remarkably long and fine lint.

A small plot of indigenous wild cotton of the country was also sown. Acting on results reported by other investigators as to the uncertain germination of the seed, all the seeds were cut or filed, and these methods were successful in obtaining a very fairly complete stand. This variety, which is probably *G. obtusifolium*, has developed a straggling habit, and needs the support of, for instance, a bush

through which it can weave its way; it did not find itself at all happy in the open field. The plants one by one gave up the struggle, only a few surviving till the end of June, and though one flower bud was observed, nothing came of it, and no seed was set.

Unit Strains.—Three unit strains were planted out, two of them from Parnell at Barberton, Z1 and Z2, and one a selection made by the writer in Tanganyika, Mp12. Three small plots, scattered in a field of maize and as remote as possible from the main crop and from each other, were planted by hand, one seed to each hole, 1 yard by 1 yard. Z1 was sown December 21, and the other two on December 29 and 30; the latter were too late to produce any crop as the wide spacing caused them to run too much to stalk and leaf, and the cold weather caught them before anything was harvested from them; a small picking was obtained from Mp12.

In the case of Z1, 630 holes were planted, resulting a month after planting in 243 plants, rather less than 40 per cent., while Mp12 produced nearly 60 per cent. Flowering began in Z1 in the middle of February, and towards the end of the month the plot was flowering freely. From time to time a number of plants were pulled out, as it was reported from Barberton that the strain was not coming true. Z2 was a nice-looking uniform plant, but produced no bolls. Mp12 was noted on April 20 as being "well grown, uniform, and flowering freely; attacked by Jassid and Aphis and rather spindly in habit, probably not much good." Later on it seemed to improve, and though it never showed much damage from Jassid, it may not have had a very heavy infection, and in any case was rather late to show it. A small quantity of seed has been secured.

Selection Work.—A start was made in the search for strains suitable for Swaziland, and 130 plants were marked, mostly in "Uganda" and "Webber 49," but also in the other varieties grown. In making these selections the first quality looked for was resistance to Jassid attack and, fortunately, this pest appeared before the season was over, though rather late. It was not possible to do much in the way of sowing any of the selected plants, though a couple of youngsters were kept busy for some time stitching up flowers on the marked plants; they were mostly too late to set.

The produce of these plants was examined primarily for lint length on the combed seed, and showed considerable variation. In the end it was decided to keep fifteen plants, and the seed from these will be planted out in progeny rows in the coming year. The table on p. 82 shows the details of these strains.

1926 SELECTIONS.

Number.	Length of Combed Lint.	Number of Seeds in 5 Grs.	Lint Index.	Per Cent. Lint to Seed Cotton.
8	26	58	3.9	31.4
11	25	54	4.2	31.1
14	27	62	4.1	33.5
15	26	49	5.0	33.0
18	25	47	4.5	31.0
19	26	61	3.5	30.5
25	25	58	4.0	31.9
48	26	61	4.2	34.2
57	25	52	4.3	30.9
60	25	46	5.0	31.8
61	25	59	3.9	31.5
62	24	45	5.6	33.5
63	27	49	4.5	30.9
75	28	58	3.0	26.2
92	26	69	2.7	27.5

Rotation Crops.—Trials were made with a few other crops which it was thought might prove profitable to grow in rotation with cotton. The Swaziland farmer depends mainly on maize; in rotation with this he may grow tobacco or cotton or very occasionally Hluba Beans (*Voandzeia subterranea*). The approach of the railway will in many parts reduce considerably the profits to be obtained from maize, and for this and for other reasons it is necessary to search for and test other crops which might be grown. Oil seeds appear to offer the most hope at present, though even the more valuable among them will scarcely pay the heavy transport charges that have to be borne; the following were tried: Groundnuts (*Arachis hypogea*), Sesamum (*Sesamum indicum*), Niger (*Guizotia abyssinica*), and Safflower (*Carthamus tinctorius*). The groundnuts grew well, and there is no doubt that this crop will play an increasingly important part in the development of the country. It is a hardy legume, which stands drought, and finds a steady export market. Further trials are arranged for a number of varieties in the coming season. Sesamum is already grown in the country and of excellent quality. It should find a ready overseas market, but does not crop very heavily, and is a difficult crop to harvest. Two farmers grew it this year under observation; each obtained about 600 lbs. to the acre. Efforts are being made to get into touch with a market. Niger did well and cropped fairly heavily; it seems worth a trial, but there is no market for it at present. The safflower suffered from the drought and gave a poor crop. A little late-sown sesamum was tried, but the season

was against winter cropping altogether. Hluba beans (*Voandzeia subterranea*) are a local product and are not uncommonly grown by farmers for issue as rations or for local sale. They are quoted in the export market. Small plots of coriander and of mustard failed completely. A plot of sunnhemp grew fairly well, and was allowed to stand for seed. It is questionable whether a fibre crop will pay, but a certain amount of interest is being expressed in *H. cannabinus*, and it is proposed to try this next year, as well as sunnhemp.

Insect Notes.—At Bremersdorp the damage done by insects was inconsiderable, and this no doubt may be ascribed to the dry nature of the season. The first to appear was the Lesser Mystery Worm (*Laphygma exigua*), which appeared on January 2 in the Standard Variety Test, when the seedlings were twelve days old. Two days after their first appearance they were found to be infesting every seedling over about an acre in extent. They were finally dealt with by handpicking, after tapping the seedling, an operation which causes the caterpillar to fall to the ground and curl up; dusting with ashes and arsenic mixed; and the use of bait. This latter was prepared from weeds which were found being eaten by the caterpillar; these were chopped up and sprinkled with locust poison, and then broadcast over the plots. The attack stopped as suddenly as it had begun, and on January 11 it was difficult to find a single specimen. Many grubs were destroyed by a small brown wasp which was seen on the hunt in large numbers.

All three Bollworms were noticed. The Spiny Bollworm was seen as early as January 6, but never attained much importance. Red Bollworm was found in the time-of-planting experiments on January 11 attacking the buds, which flared and shed. It was not always easy to identify the grub, which was extremely minute, but many were found. A very heavy shedding of bolls was noticed in these plots in the following month, and on February 12 a number of these fallen bolls was collected and examined; about 17 per cent. were or had been affected by grubs, but it was not always possible to say definitely the particular worm responsible. For some time a daily examination was made in Plot 1D, and the shedding was found to be very heavy; in nineteen days over 5,000 were shed on this $\frac{1}{20}$ acre plot, while flower production on the same area was 1,680. (This was the plot that yielded 1,000 lbs. of seed cotton to the acre.) The percentage of bollworm damage gradually diminished, and the cause of most of the shedding was probably physiological. The Red Bollworm seemed to be responsible for most of the insect damage that was done; only small specimens could be found, about a

quarter grown. The American Bollworm did no damage here, but two severe outbreaks occurred in the district. In both cases the standing cotton was practically stripped of bolls, but the grub pupated and disappeared, and the crop produced a fresh lot of flowers and ultimately yielded satisfactorily.

The Red Bollworm is the really important one, and experiments were undertaken to watch its behaviour during the winter months. Besides observations of special stand-over crops, a collection of bolls was made in the field on June 15 and 30 and kept under observation. No emergence of moths has taken place up to the end of September, a point of some importance as showing that a close period may not be completely successful in dealing with the pest. That some emergence does take place in natural conditions is shown by the fact that half-grown caterpillars have been found in September in such half stand-over cotton.

The Jassid has been mentioned. The insect was first noticed in Bremersdorp early in February, but made little progress and was only prevalent to a small extent by the end of the month. Towards the end of March it was noted as "lamentably slow in coming," and on April 5 it was reported, "Jassid abundant, but except in spots does not make much progress." Selection for Jassid-resistant plants was started on this date, though it was realized that it was uncertain. The general effect of the pest was that though it became pretty universal from this date, it was too late to interfere with the earlier sown plots, which had already set their crop. In the case of the late plots it undoubtedly lowered the yield considerably.

Later in the season it passed off, and in many cases plants put out quite a quantity of new foliage which seemed quite unaffected. One point may be noted. In selecting plants for resistance, it was again and again found that the eye was caught by plants which had lost their leading shoot, and had thus bifurcated into two equal stems (owing to the attack of *Laphygma* there were quite a number of these). Presumably these plants were later in development than the normal, and as they were still growing were more resistant than plants whose growth had ceased.

The case of "Cleveland" has been already noted; in this variety the response to the attack of Jassid was a darkening of the leaf to a deep reddish-purple, while the bending over of the leaf was much less marked than usual. This effect was also noted in Z2.

In the district Jassid attack varied considerably, but mostly it came too late to do much harm. The luxuriant crop at Red Tiger suffered more than the scorched and stunted crop at Headquarters,

though in another series of plots near the White Umbelusi (H. S. Parry, Matindeli), where the drought was very severe and the soil on the sandy side, the plants, even the young ones, were completely destroyed by Jassid. On the flats the attack was slight.

Aphis attacked all the plots at Bremersdorp more or less intermittently. Its effect was distinguishable from that produced by Jassid; the latter caused the leaves to turn down at the edges, while the aphis caused the whole leaf to become crinkled.

The stainers are responsible for much damage to the cotton, and a considerable quantity of stained yellow cotton is to be attributed to them. This "internal boll-rot" is alleged to be caused by the inoculation of the green boll with fungi, carried on the beak of the stainer, which pest appeared in large numbers towards the end of the season. It is probable that the Red Stainer (*Dysdercus* sp.) is responsible for most of the damage, though the small Black Stainer (*Oxycaenus*) was also plentiful. Enormous numbers of the Red Stainer have been observed in the field and about clumps of cotton seed, but it is anticipated that a vigorous close season will be effective in keeping their numbers down. They are a most serious pest and cause a very considerable loss by reducing the quality of the cotton.

A Fruit Beetle (*Pachnoda* sp.) was observed on one or two occasions attacking green bolls.

Red Spider has also been noticed doing damage to cotton plants.

Miscellaneous.—A small manual-draft blade hoe, designed on Indian lines, and after the pattern described by Mr. Sampson (*Empire Cotton Growing Review*, ii., p. 319, Figs. 3 and 4) was prepared with Mr. Coates's assistance, and was found most useful in the plots where bullocks could not be used. A flexible tined weeder was also purchased, but the dry season afforded little opportunity for its use.

A trial was made of a cotton stalk cutter. It appeared likely, in view of the compulsory cutting and burning of all aboveground portions of the plant, that there was room for an efficient machine that would do this work. Unfortunately the machine obtained did not perform the work satisfactorily. It consists of a series of heavy blades arranged radially on the periphery of a cylinder at such a distance that their edges are 12 inches apart; these blades press on the ground one after the other as the machine is pulled forward, and by the weight of the machine cut into the ground. Machines with blades nearer than 12 inches can be obtained, but apart from the fact that this special machine leaves stumps up to a foot in height, which may be carrying bolls and flowers, it does not cut efficiently. If the ground is soft the stalks give to the blades, while if the ground

is hard it is likely that the blades would soon become blunt. It may be said that a machine of this nature is unlikely to be of any practical use.

A visit was paid to Piet Retief to inspect a machine which is the invention of a mechanic there, which is designed to pull the cotton stalks out of the ground. Two horizontal geared cylinders pass the stalks to a third idle cylinder, which is kept tightly in contact with the second cylinder by means of springs. The inventor had not completed his machine and had given it no real trial, so that it is difficult to say just what its effect would be. He was assured the Corporation would afford him assistance in bringing the machine to the trial stage.

APPENDIX.

TEMPERATURE RECORDS (1925-26).

	<i>Oct.</i>	<i>Nov.</i>	<i>Dec.</i>	<i>Jan.</i>	<i>Feb.</i>	<i>Mar.</i>	<i>April.</i>	<i>May.</i>
<i>Natalia Ranch : Headquarters.</i>								
Average maximum ..	80.5	88.6	93.6	90.0	92.9	87.3	86.1	80.4
„ minimum ..	60.4	64.2	67.6	68.0	68.5	65.7	58.1	52.0
<i>Bremersdorp.</i>								
Average maximum ..	79.1	82.3	89.5	84.5	86.9	82.5	78.7	73.8
„ minimum ..	57.7	60.9	63.7	64.8	66.3	65.7	63.1	54.0
<i>Ingwavuma : Cotton Plantations.</i>								
Average maximum ..	84.0	89.0	93.0	93.0	94.0	88.0	77.0	79
„ minimum ..	60.0	63.0	66.0	65.0	66.0	60.0	56.0	50

SOUTHERN RHODESIA

REPORT ON THE COTTON-BREEDING STATION, GATOOMA, FOR THE SEASON 1925—1926

INTRODUCTORY NOTE BY MR. G. S. CAMERON.

THE account which follows is a combination of a report by Mr. I. G. Hamilton, who was in charge of the station for the greater part of the season, and another complementary thereto, by Mr. J. E. Peat, who opened the station, laid out and planted the plots, and who eventually took over charge on Mr. Hamilton's transfer to Barberton.

There is little for me to add to either report; the results obtained from the year's work at Gatooma are more satisfactory than the season led me to anticipate; further work of a corroborative nature is required, however, before we can decide whether to concentrate on any one particular variety of cotton. Considering the limited range of varieties with which we had to work it is significant that all varieties in the trials should have turned out better than Improved Bancroft. Now that we hope to have a larger choice of varieties from which to select (depending on the number of varieties and quantities of seed released by the Entomological Section), the chances of finding a cotton more promising even than the Express or Delfos are considerably increased. This, however, is work which lies further ahead. This year we shall have to decide on whether we are to put out the Express or Delfos. The Trice and Acala varieties are out of the running meanwhile on account of their inferior lint length.

The question of getting out the new variety, once we decide which one it is to be, does not come within the scope of this report, and will be treated elsewhere.

Stress has been laid on the damage done by Jassid, but it is difficult to say how much the weakening of the lint was due to Jassid and how much to stainers. In my opinion, as far as Southern Rhodesia is concerned, the latter are much more to be feared than the former.

The bee-proof cage has proved its value in more than one direction, but I do not propose to make any extensions to it this season.

The programme of work for the ensuing year is a fairly heavy

one, but with a favourable season I have every confidence in its being carried out effectively.

The rougher side of the work, such as buildings, road-making, etc., is now well in hand. A considerable amount of rearranging of fields is necessary to bring the stations into alignment with the boundaries which have recently been defined. All we ask now is a good season, without which any amount of planning is useless, in addition to which the work becomes discouraging. As Southern Rhodesia has just come through two seasons, 1924-25 and 1925-26, the latter of which was abnormally dry, while the former provided a rainfall which was a record for recent years, we are now led to believe that the worst is past, and look forward with hope to the future.

COTTON-BREEDING STATION, GATOOMA: REPORT 1925—1926

BY

I. G. HAMILTON AND J. E. PEAT.

The cotton-breeding station, Gatooma, comprises 500 acres within the Gatooma municipal area, being situated on the boundary about two miles from the centre of the town. The altitude of the farm is 3,774 feet, and the district is in general flat, with occasional low-lying hills. There is no permanent supply of surface water in the immediate neighbourhood, though there appears to be an adequate subterranean supply, which is pumped from a depth of about 60 feet. The rainfall is somewhat irregular from year to year, but averages about 30 inches, and falls practically entirely in the period from the beginning of October to the end of March. This rainy period is roughly divided into two shorter periods, the first to the end of December being characterized by scattered showers, and the second, to the end of March, by the more or less continuous monsoonal rains.

The greater portion of the farm consists of a chocolate loam soil inclined to be clayey; this soil overlies greenstone for the most part, and is typical of the soils on which most of the agricultural development in the Gatooma area is taking place. There are occasional outcrops of felsitic rock, however, and a few acres in the eastern corner of the farm show a true felsitic soil, greyish in colour and particularly clayey in nature. This type of soil is seen on some of the land on the eastern side of the railway line; it is particularly difficult to keep in tilth, and if not worked immediately after rain,

will set so hard that the cultivators simply ride over the surface without penetrating.

About 80 acres of the area had been under crop or ploughed the previous year when the farm had been run conjointly by the Government and by the Gatooma Municipality as a general experimental area. Mr. Cameron secured control of the farm, together with an additional area, in August, for the purpose of using it as a cotton-breeding station.

Before the planting rains fell the work of clearing, ploughing, and cultivating was pushed on, and the erection of a shed, a store, and a house for the plant breeder was begun.

In accordance with the programme for the season, the areas under crop were respectively about 80 acres of cotton, 30 acres of mealies, and 1 acre of groundnuts, making a total of 111 acres, 40 acres of the cotton being on newly broken land.

The sowings of cotton included bulk plantings of Improved Bancroft, a spacing test with this variety, a varietal test between Improved Bancroft, Delfos, Acala, Trice, and Express, $\frac{3}{4}$ -acre bulk plots of Trice, Acala, Express, and Delfos, and in addition numerous small plots of other varieties obtained chiefly from Mr. Parnell at Barberton and from Mr. Taylor, who had lately resigned his post as Cotton and Tobacco Adviser to the Rhodesian Government. With the exception of two small rows sown with seed from a perennial plant growing at Belingwe, there were no single-plant selections. Owing to delay through first having to pass through the process of fumigation, a small number of single-plant selections of the Durango variety and some bulk Lone Star seed from Queensland were not sown till January 13.

From Mr. Cameron's observations during the previous season it had appeared that one of the varieties Delfos, Acala, Trice, or Express might prove sufficiently good to multiply up straight away to replace the Improved Bancroft variety, which was being grown almost exclusively throughout the country. It was accordingly decided to gather as complete information as possible by means of flowering, bolling, and growth records, as well as by general notes on the behaviour of these varieties under local conditions.

Special attention throughout the season was paid to the necessity of procuring good single-plant selections for the commencement of pure-line work, as further progress of a permanent nature must necessarily depend on the care and accuracy with which this work is initiated and carried out. An attempt was made to select plants early in the season which might prove suitable and get some self-

fertilized seed from them during the first year. A number of plants in each of the main varieties were early marked out for this work and their flowers tied up; unfortunately a rough examination at the end of the season showed that very few of these plants would be worth going on with. The expense of selfing, however, is very small; one boy, costing altogether about 26s. per month, did most of the work of tying up the flowers on a total of about 400 plants; he was helped for a short period during the height of flowering by another boy. Flowering, however, never attained more than a comparatively low rate, and it is possible that in another season more labour might be required to tie up the flowers on the same number of plants. The main trouble during the present season has been that the majority of the selfed bolls have been shed through one cause or another.

With the idea of using it for obtaining self-fertilized seed a small bee-proof cage was constructed. This contained a few plants of each of the main varieties, making a total of sixty plants. In order to get information on the possibilities of this structure, plant diagrams and three-day height measurements were kept of the whole of these plants; these records, in addition to general notes on the incidence of disease, etc., were thus available for comparison with similar records of plants under ordinary field conditions.

The bulk of the planting was done during the last week in November and the first week in December, with the exception of a 40-acre block of cotton on new land which was planted later. There was every indication at first that a good stand would be obtained over practically the whole area. Unfortunately the rain on which the planting had been done had been hardly sufficient to soak the ground thoroughly, with the result that the hot, dry spell which ensued resulted in a large proportion of the plants being killed off before they had been able to penetrate to the lower soil moisture and thus establish themselves. Light cultivation of the surface soil to conserve the moisture failed to prevent plants dying, and when heavy rains fell during the first week in January the stand had been considerably reduced, even by as much as 50 per cent. on some plots. Although rather late, replanting was carried out over most of the area, and a complete stand again established. This stand was again somewhat reduced, chiefly by white ants, which were particularly virulent in parts of the crop.

From the beginning of January to March 19 rainy weather was practically continuous, with the exception of a short dry period for about a week towards the end of January. Clouds hung about fairly continuously during this period, and the day temperatures

were kept rather low: the average maximum temperatures for January and February were 82.1° F. and 83.4° F., and the average minima 63.9° F. and 64.7° F. respectively. Once the plants obtained a sufficiency of moisture following on the rain of January 4 and subsequent rains, they responded by making satisfactory progress, and at one time, considering the lateness of the sowing, there seemed a prospect that a medium picking might be obtained from some of the plots. The first flowers began to appear during the second week in February, and flowers were being produced in largest numbers during the last three or four days in March; by April 19 flowering had again practically ceased, and the plants were again suffering rather severely from lack of moisture.

Up to the beginning of April there had only been a relatively small amount of shedding, but about this time the American Boll-worm (*Chloridea obsoleta*) began to appear in fair numbers, with the result that during the first three weeks in April the crop was rather severely damaged, squares and young and old bolls all being attacked, and all hopes of getting much crop were entirely dispelled as the flower buds were practically all destroyed and the season too far advanced.

JASSID.

The characteristic reddening of the leaves caused by Jassid was first apparent about the middle of February on some of the newly introduced American varieties. Some plants of Improved Bancroft showed colouration towards the end of February, and by the beginning of March practically the whole area was affected, with the exception of certain varieties, notably Cambodia and Tanguis, which were completely resistant to its attack and maintained the green colour of their leaves to the end of the season.

Sea Island, a glabrous plant, contrary to what appears to have been found elsewhere (*vide* Mumford's paper on "Sap-feeding Insects of the Cotton Plant"), appeared to be very, if not entirely, resistant. Unfortunately these three varieties are all late-maturing.

The Z.1 selection from Barberton, which Mr. Parnell reports shows marked resistance to Jassid there, appeared here, judged by the reddening and later the withering of the leaves, to show no more resistance to Jassid than most of the other varieties grown.

In comparing the cage plants with those outside it seems likely that Jassid is largely responsible for the light bolls, and the weak and immature fibre which characterized practically the whole crop.

From the patchiness of the reddening on some plots it seems that

soil conditions exert some slight control on the effect of a Jassid attack.

There appeared to be no possibility of getting Jassid-proof selections in the newly introduced American varieties, as these seemed to be uniformly susceptible, though some differences were to be seen on comparing the varieties as a whole; Meade was the first to show obvious signs of Jassid attack and Acala was the last; this latter variety appeared to be only slightly more susceptible than Improved Bancroft. The individual plants of Improved Bancroft were shown, on inspection, to be very diverse in their reaction to Jassid, some plants being killed outright, while others were absolutely resistant, whereas the vast majority showed a more or less intermediate reaction.

PESTS AND DISEASES.

Apart from Jassid, which, according to results obtained by Mr. Parnell at Barberton, will definitely come within the control of the plant breeder, a number of other pests and diseases were responsible for varying amounts of damage. The American Bollworm was undoubtedly the most serious pest. It was first detected by the flaring of odd squares during the first week in February; during March a certain amount of shedding of young bolls was occasioned by its attack, and, as already mentioned, during April it was particularly virulent. Our farm and a few of the immediately surrounding cotton areas were no doubt particularly unfortunate in being thus attacked, as areas further away were comparatively lightly affected. This localized attack is in keeping with the reputation of this pest, though no doubt the fact that cotton had been grown near us for two seasons previously and that there were some dirty patches of ratooned and stand-over cotton close by contributed to its success.

Of the other bollworms, the Spiny did some slight damage, while the Sudan did not appear to be present. Aphis was present throughout the season from the middle of January, being bad at times on certain patches. White ants were responsible for an unusual amount of damage; they killed the plants by eating through the stems at about ground-level; on one morning as many as eighty plants on a 1-acre plot were counted to have fallen down overnight from this cause. Stainers were present comparatively early, though they were not obviously abundant till shortly after the bolls began to open, about the beginning of May. A certain amount of angular leaf spot was apparent during February and March on the lower

leaves, though the amount of damage was practically negligible, and only in one or two cases were bolls seen to be infected. Boll-rots were particularly bad, and about a third of the bolls seemed to be infected with this disease at a comparatively early stage in their development.

BEE-PROOF CAGE.

The cage plants were sown on December 9 and were watered three or four times to help them over the dry spell till the rains commenced in January. Hoeing by hand was done periodically. A number of the plants suffered rather badly from Aphis for a while, and were sprayed with nicotine solution on February 26.

The cage is a structure about 30 feet long by 10 feet wide and 8½ feet high, and consists of a light steel framework covered with ordinary mosquito netting; it cost £40 to construct. In addition to keeping out insects liable to cause crossing, it excluded practically all the pests liable to injure the plant; besides Aphis, the only other pests observed to obtain entrance were a leaf-miner which did no damage worth consideration, and a few Jassids which reddened the tips of some of the leaves. The plant data have not yet been completely examined, but it appears that the development of the plants is considerably retarded by being grown in a cage, otherwise they grew to a more or less normal size, and owing to the comparatively complete absence of Jassid their leaves remained green till the end of the season.

None of the cotton harvested from the plants in the cage was stained. This observation is interesting in view of the argument that has been put forward that climatic conditions this season were responsible as much as, if not more than, the Stainers for the enormous quantities of stained cotton in this year's crop.

It appears that although a small cage like that employed this season can be made use of in many ways, more extended use of this type of structure for the general work of self-fertilization is not justified, as the work can be done more cheaply by tying up the flowers by hand under ordinary field conditions where the plants could also be under observation for Jassid reaction, and no doubt much could be done by hand-picking to keep special plants free from bollworms.

YIELDS.

The best yield obtained on the farm from an acre plot of the ordinary Improved Bancroft was one of 200 lbs. seed-cotton, and was grown on the felsitic soil. There were nine acre plots on this

type of soil; these followed different crops of the previous season—groundnuts, Kaffir corn, Kinvarra oats, Boer manna, Sudan grass, Dolichos beans, Velvet beans, and maize (two plots); there was nothing of a suggestive nature as to the effect of any of these crops on a succeeding cotton crop in the results obtained from these plots.

The average yield from the plots on the felsitic soil was much in excess of that from the chocolate soil, though this appears to be attributable to the fact that the first sowing suffered far less destruction on this soil than on the chocolate soil, rather than to its being in any way necessarily a better soil.

With regard to the trials, the spacing trial was a complete failure, while satisfactory yields from the variety trial were not obtained on account of the destruction of most of the first sowing by the dry spell and also on account of the bollworm attack. Resown plants throughout were too late to produce any cotton worth consideration. Each variety was replicated four times on plots of $\frac{1}{20}$ acre in area.

The following were the yields obtained:

<i>Variety.</i>	<i>Yield</i> ($\frac{1}{20}$ -Acre Plots).	<i>Yield</i> (Lbs. per Acre).	<i>Yield</i> (Average).	<i>Yield</i> (cf. Improved Bancroft 100).
Delfos	a 12	240	157.5	159.5
	b $6\frac{1}{2}$	130		
	c 7	140		
	d 6	120		
Acala	a $9\frac{1}{2}$	190	138.75	140.5
	b $5\frac{1}{2}$	110		
	c $6\frac{1}{2}$	130		
	d $6\frac{1}{4}$	125		
Improved Bancroft	a $7\frac{1}{4}$	145	98.75	100.0
	b 4	80		
	c $4\frac{1}{2}$	90		
	d 4	80		
Trice	a $8\frac{1}{2}$	170	150.0	151.9
	b $6\frac{1}{2}$	130		
	c $5\frac{1}{4}$	105		
	d $9\frac{3}{4}$	195		
Express	a $7\frac{3}{4}$	155	156.25	158.2
	b $6\frac{3}{4}$	135		
	c $6\frac{1}{4}$	130		
	d $10\frac{1}{4}$	205		

From the above figures it will be seen that all the four new varieties give a considerable increase in yield over Improved Bancroft. The actual difference between Improved Bancroft and the next lowest yielding variety, Acala, is approximately three times the probable error of their difference, so that Acala is justifiably regarded as being

a higher-yielding variety than Bancroft under the conditions which prevailed during the present season, and so also the other varieties which show higher yields than Acala, though no significance attaches to any differences between the new varieties themselves.

A preliminary examination of the lint of the varieties grown last season and of the single-plant selections has been made. It is hoped to make a more detailed examination of the lint of the more promising varieties after the planting for the season 1926-27 is finished.

The samples of seed-cotton were chosen at random from the bulk pickings. The lint was fluffed to a wing, a tuft pulled, and the mean maximum length measured. At the same time for each measurement an index figure of from 1 to 10, for quality, was noted, in which an attempt was made to take into consideration length, strength, uniformity of lint length on the seed, and probable ginning percentage.

The following are the measurements for the varieties tested this past season in variety trials. Twenty-five determinations were made for each variety.

<i>Variety.</i>	<i>Mean Lint Length in Mm.</i>	<i>Standard Deviation (Mm.).</i>	<i>Standard Error of the Mean (Mm.).</i>	<i>Index Figure for Quality.</i>
Delfos	25.7	1.7	0.34	5.4
Acala	21.9	2.0	0.40	3.8
Improved Bancroft ..	24.4	2.6	0.52	3.9
Trice	21.3	1.7	0.34	4
Express.. .. .	24.8	1.4	0.28	5.1

The standard deviation and the standard error of the mean for Delfos are probably higher than would have been the case had a larger number of measurements been made. Omitting a single low measurement of 20 mm., the mean of the remaining twenty-four determinations is 25.9 mm. with a standard deviation of 1.2 mm., and a standard error of the mean of 0.24 mm.

The differences in mean lint length between Delfos and Express and Improved Bancroft are not significant. The standard error of the difference between Delfos and Improved Bancroft is 0.62 mm., and the difference between the means 1.3 mm. The standard error of the difference between Acala and Improved Bancroft is 0.66 mm., and the difference 2.5 mm.; thus there are significant differences between the mean lint lengths of Acala and Trice and Improved Bancroft.

The Durango single-plant selections brought from Queensland by Mr. Hamilton, though planted very late, yielded lint of relatively good quality, with a mean lint length of 27 mm.

FLOWERING AND BOLLING RECORDS.

The $\frac{3}{4}$ -acre bulk plots were used for obtaining the flowering (Fig. 1) and bolling (Fig. 2) data.

These records show clearly that Express is slightly earlier than Delfos, Trice, and Acala, and that all these are much more so than Improved Bancroft. The plots were sown on November 30, and the commencement of flowering varied from February 7, in the Express variety, to February 20 in the Improved Bancroft—i.e., from 69 to 82 days after planting respectively. The curves gradually converge to a maximum for all varieties about March 29 and 30, 119 to 120 days after planting, and then decrease rapidly and simultaneously, flowering having practically ceased by April 23.

The bolling curve constructed from weekly pickings bears out the total yields obtained from the entire plots, and also those from the variety trials. The flattening out of the curves in the middle is indicative of the severity of the bollworm attack. It is seen that Delfos maintains its curve slightly higher towards the end of the season than the other varieties, having evidently for some reason suffered slightly less from bollworm.

In comparing these curves with those obtained in other cotton-growing countries, the low rates of both flowering and bolling are especially striking and disappointing. The weight of the individual bolls was very low; of the bolls which ripened during the week ending June 1 and were used for the boll-recording work, it required from 117 to 118 from the Express and Acala varieties to make a pound of seed-cotton, whereas the other varieties, Delfos, Trice, and Improved Bancroft, required from 132 to 136 to make a pound.

IMPROVEMENTS.

During the season the gradual provision of efficient equipment and adequate accommodation at the cotton-breeding station was carried further forward. The house was completed, and a laboratory, an office, and a foreman's house erected. More land was cleared and brought under the plough, and further farm and laboratory equipment were secured as required.

The Rhodesian Government, through Mr. Cameron, showed their willingness to do everything within reason to increase the efficiency of the station and the comfort of the staff.

FIELD SELECTION WORK.

In this work the aim was to select small to medium-sized plants, bearing well, devoid so far as possible of big vegetative branches, with short internodes, showing signs of maturing fairly early, with good-sized bolls elongated rather than round, with lint fairly regular and of length 1 to $1\frac{1}{8}$ and $1\frac{3}{16}$ inches. Of such plants very few could be found.

In all the field crops visited, no plants of any quality could be selected which showed also any marked degree of Jassid resistance, as measured by the reddening and later the withering of the leaves.

CONCLUSION.

One naturally hesitates to draw any too definite conclusions after the experience of only one season, and the more so as the season has been a particularly unfortunate one in many ways, from the late planting of the crop in the first instance, to the further unfavourable conditions through which it had to pass.

It will be advisable to try out further most of the varieties gathered together for at least one season more, when better conditions might prevail, but judging from the present season's experience the most promising varieties appear to be those included in the variety trials, the results of which show that the four new varieties tried against Bancroft are all superior to it in yielding power. In discriminating between these varieties the choice will probably fall firstly on Express, and secondly on Delfos. These show a better length and uniformity of lint than the other varieties; Express shows a slightly larger boll than Delfos and Trice, while its somewhat earlier qualities seem to be eminently desirable in a district where, to judge from one season, the development periods tend to be inordinately long. However, as already pointed out, all the new varieties are to a greater or less extent susceptible to Jassid, and there appears to be no chance of selecting absolutely resistant types out of them. A large number of selections of the best plants in all the varieties which appeared most promising were, however, made. It might be possible to use Cambodia with advantage in cross-breeding work with these selections to get Jassid-resistant strains; crosses between Cambodia and the Express selections suggest themselves as being most likely to yield profitable results.

The variety Tanguis which also stood out as showing complete Jassid resistance cannot be regarded as suitable for crossing work, as it is not an Upland type, but belongs to the species *Gossypium*

peruvianum, and shows characters which contrast widely with this type.

Jassid-resistant plants can, however, be found in the Improved Bancroft variety, and selection work in this variety may prove to be the quickest way of getting satisfactory results.

The work of getting suitable selections during the past season has been rendered very difficult on the station on account of the very heavy shedding from one cause or another; this, of course, made it impossible to form an idea of what a plant's natural bearing capabilities might be under more favourable conditions.

In addition to the need for breeding out a Jassid-resistant, early-maturing variety suitable for local conditions, another matter which appears to need stressing is earlier planting. Records of rainfall (Table I.) in the Gatooma area over a number of years show that there is an almost complete absence of winter rains; the result is that the first scattered showers in spring are used for preparing the seed-bed instead of for planting. Every effort should be made to prepare the land early so that planting can be done on the first suitable rains. One frequently hears it said that early planting is not necessary, and the satisfactory results of two seasons ago are quoted in support of the statement; enquiry, however, elicits the fact that it was the high price then ruling which was responsible for the satisfactory result rather than the yields, which were very ordinary. During last season, of course, the crop with a few exceptions was a complete failure; the best yield on our farm, for instance, did not exceed 200 lbs. seed-cotton per acre; this crop was also planted late.

The results to be obtained from different times of planting should form an interesting subject for investigation, and also the economic possibilities of fallowing the land for a season to conserve moisture and get the land well worked down so that early planting can be secured.

Season 1926-27.—In preparation for the work of the coming season all the ploughed land—there are now 160 acres under the plough at the station—was ploughed during the spring and has been cross-ploughed since. Part of the cotton next season is to be planted on land which bore maize last season, and the remainder on new land, ploughed for the first time during the spring rains. All possible precautions are to be taken to decrease the severity of the attack of insect pests. Crops of maize and sweet corn are to be planted as trap-crops for bollworms, and heaps of cotton seed will be used as traps for stainers. Arrangements are being made, if necessary, to dust the growing crops with an arsenical.

TABLE I.—RAINFALL: GATOOMA, 1908-26.

(AVERAGE=32.15 INCHES.)

	1908-9	1909-10	1910-11	1911-12	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19	1919-20	1920-21	1921-22	1922-23	1923-24	1924-25	1925-26
July ..	—	—	0.25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.13
August ..	—	—	—	—	—	0.05	—	—	.13	—	—	—	—	—	—	—	0.05	—
September	—	0.14	—	—	0.05	0.07	—	0.03	0.45	—	—	—	—	0.12	—	—	—	1.34
October ..	0.17	0.71	3.16	2.45	0.19	2.11	—	1.16	0.15	0.54	0.23	1.26	1.44	1.21	3.50	0.42	0.82	1.73
November	2.45	1.63	8.24	1.78	7.30	3.23	3.35	3.35	2.75	4.72	3.46	2.39	2.10	4.96	1.99	1.56	4.97	1.52
December	5.46	6.95	2.98	4.61	—	2.55	16.68	4.85	11.28	13.46	8.08	4.61	2.14	9.38	6.11	4.91	10.66	2.87
January ..	17.00	1.66	9.90	6.35	4.02	6.53	9.58	6.68	1.98	11.98	13.24	6.30	8.88	1.02	8.56	3.83	9.81	6.70
February..	5.28	8.32	8.25	1.83	10.58	10.03	8.03	2.21	1.33	15.41	6.12	11.57	14.05	2.23	8.19	8.09	12.71	5.58
March ..	6.88	6.63	0.82	2.45	2.81	0.04	2.72	1.57	2.16	4.71	1.52	4.56	9.84	1.56	11.93	4.72	8.91	6.45
April ..	0.35	0.43	0.86	1.28	3.70	—	0.18	0.33	0.83	—	0.08	—	1.34	0.22	—	—	4.35	0.38
May ..	0.46	—	1.65	0.95	0.94	—	0.06	—	1.70	—	0.08	0.90	0.25	0.25	—	—	0.10	—
June ..	—	—	—	0.21	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals ..	38.05	26.47	35.51	21.94	29.59	24.56	40.60	20.18	22.76	50.82	32.81	31.59	40.04	20.95	40.27	23.53	52.38	26.70

From a consideration of the results of last season's variety trials, it has been decided to omit Acala and Trice from the trials this season, though they will still be grown in observation plots, and if sufficient seed can be released by the entomologist, to include Durango. These trials will be replicated eight times, four replications on old land and four on new land. They will again be tested against Improved Bancroft. If sufficient seed is available, Delfos, Express, and Durango will be bulked up at a wide spacing, as far removed from each other and from the rest of the cotton as is possible. It is hoped that by the end of the season we shall be in a position to issue a quantity of one of the varieties being bulked, either to selected farmers or in small quantities to growers. In other plots observations and records will be taken on these varieties.

If all the varieties and strains ordered arrive, and are freed by the entomologist in time, there will be about seventy of these in small observation plots for observation and record.

There are about ninety single-plant selections in Express, Acala, Delfos, Trice, Z.1, and Improved Bancroft to be grown in progeny rows next season. The best of these rows will be hand-selved. The seed from the best selection of all will be planted out in the insect-proof cage. Next season further selections will be made in the bulk plots.

At Mr. Cameron's suggestion a few plants of each of the varieties and strains are to be grown on land well kraal-manured to observe their growth and habit on rich soil.

As a suggestion from the Conference in Kenya, observations are to be taken on the comparative growth of plants from seed treated with sulphuric acid and seed not so treated.

The spacing trials, distance of plants apart in the row, will be continued. This season these trials will be replicated eight times.

Some general observations will be made on the effect of known quantities of certain fertilizers on the growth and health of cotton on the station.

At present an attempt is being made to find out the most suitable bean to plant here, and the best way of planting it with single cotton seeds, to break the crust and assist single seeds to braird—seeds, perhaps, from a single valuable plant or from a small quantity of a valuable strain.

FIG. I
 FLOWERING CURVES - FLOWERS PER PLANT PER DAY. FIVE DAY MEANS

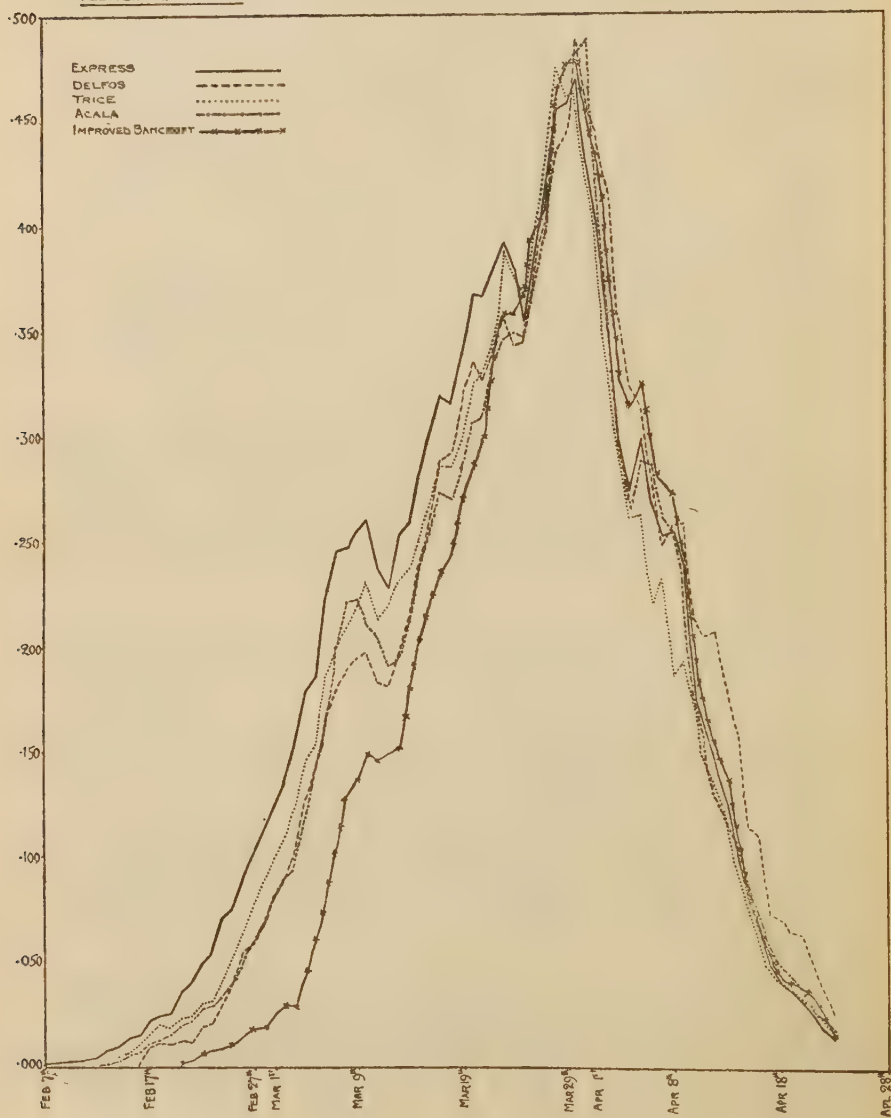


FIG. II.

BOLLING CURVES.— BOLLS PER PLANT PER DAY WEEKLY PICKINGS.

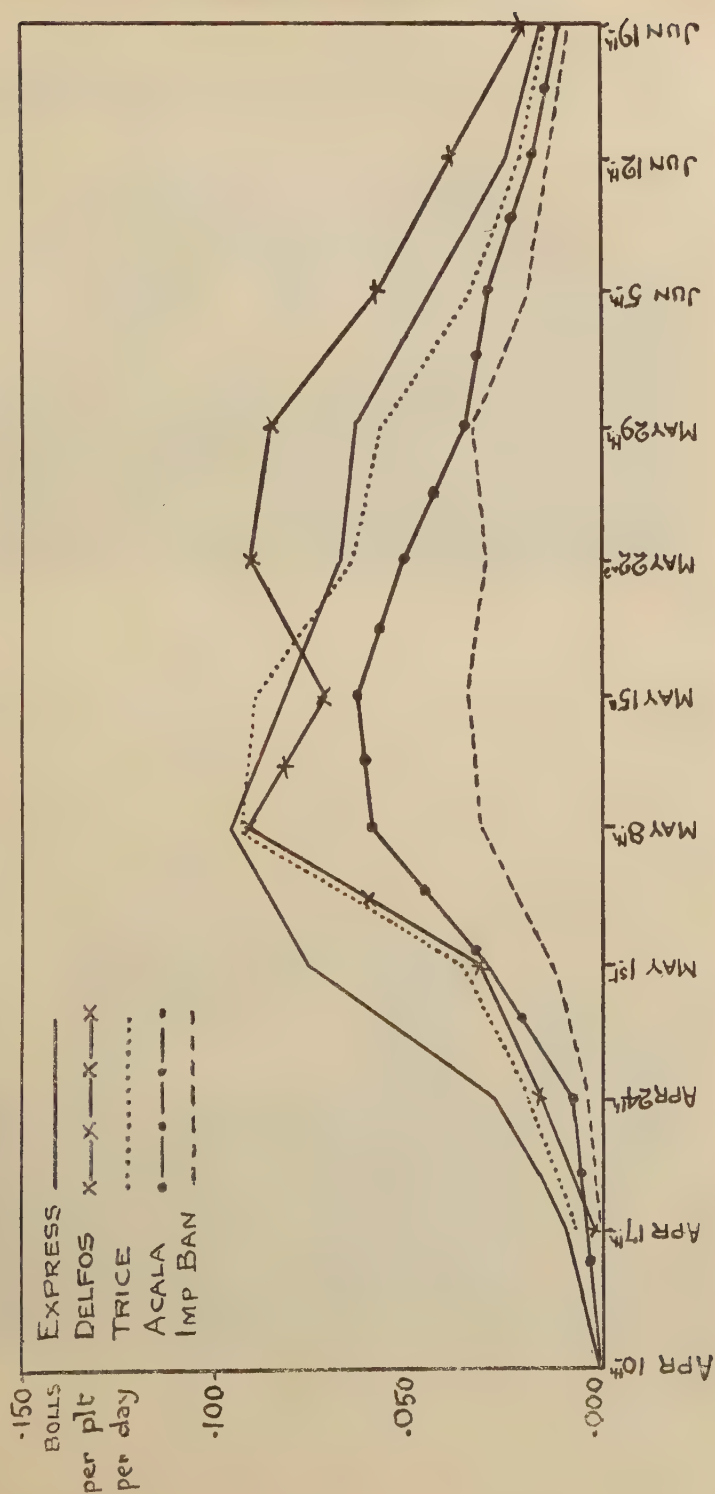


FIG. III.

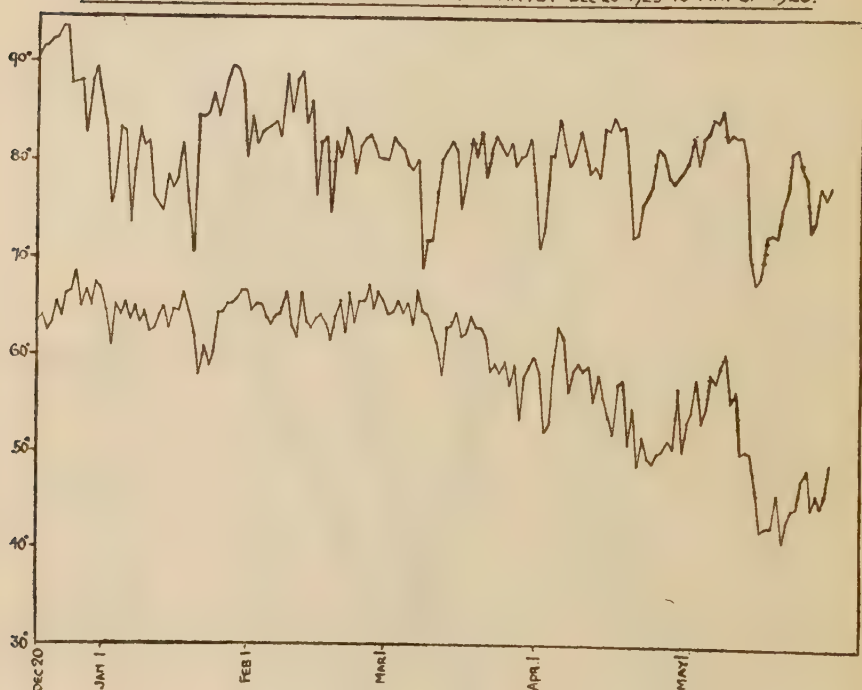
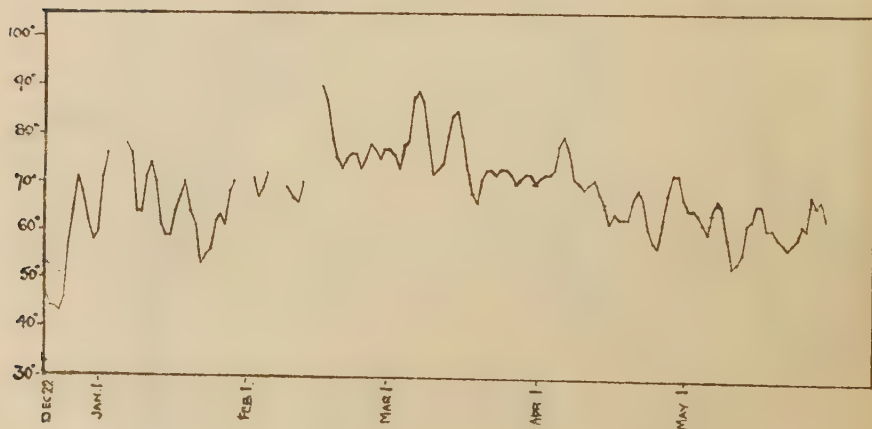
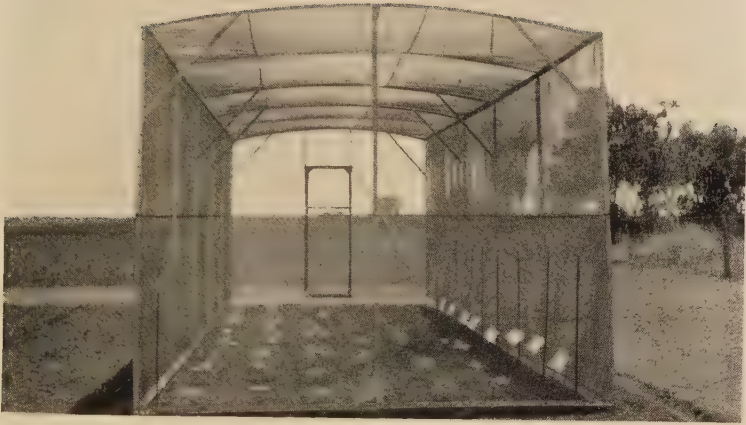
MAXIMUM AND MINIMUM TEMPERATURE CHARTS. Dec 20th 1925 to May 31st 1926.

FIG. IV.

HUMIDITY CHART. DEC 22 TO MAY 31. THREE DAY MEANS.
 READINGS TAKEN ONCE DAILY AT 8:15 A.M.





THE INSECT-PROOF CAGE, GATOOMA—JANUARY.



THE INSECT-PROOF CAGE, GATOOMA—MAY.

ANGLO-EGYPTIAN SUDAN

REPORT ON THE WORK ON COTTON CARRIED OUT BY THE PLANT-BREEDING SECTION— SEASON 1925-26

BY
M. A. BAILEY.

PART I.—INTRODUCTORY.

(1) DEFINITION OF THE COTTON YEAR.

THE time of planting cotton and the period during which the crop occupies the ground vary considerably within the large and scattered areas over which cotton-growing is spread in this country.

In the north, in Berber and Dongola Provinces, early planting is the rule, June or July being the usual months. Late planting is inadvisable owing to the possibility of low temperatures, dropping occasionally to 1° C. in the winter months.

In the Gezira area, planting was formerly carried out about the middle of July, but the general tendency in that area is towards later sowing, most of the crop now being sown during August, and some later still. In the season under review it appears from experiments carried out on the Gezira Research Farm that there has been a definite advantage in late sowings.

In the southern rain areas the date of planting has to be adjusted so as to ensure that the bolls do not open before the greater part of the rains are over. This, with American varieties, means sowing about the end of July, or later still, in the most southerly localities.

The duration of cotton-picking also varies considerably.

Picking in the Gezira starts in December, and is carried on right through April into part of May, whilst, in the case of some of the rain districts, lack of water brings cotton-picking to an end as early as December.

At the Experimental Farm at Shambat it has been usual to sow most of the cotton in June, before the short rainy period commenced, but in the present season later sowing is being tried with the idea of falling more into line with Gezira practice.

Pickings at the Shambat Farm have been taken in previous years as late as April or May, but the cotton is so inferior that it has been

decided in future to cut out the relatively small portion of the crop which might open after the end of March. It is suggested that a similar procedure might be adopted with advantage in the Gezira area, the water thus saved being used for a further extension of the area bearing cotton.

It is hoped that it will be possible to obtain further evidence during the coming season on this question of the tailing-off of the quality of the crop.

For the purpose of an Annual Report it would seem convenient, from a consideration of the sowing and picking dates summarized above, to regard the cotton year as starting from May 1 in each year, and this will be adhered to in this and in subsequent reports.

(2) ORGANIZATION OF PLANT-BREEDING WORK.

The present Experimental Farm at Shambat has been in existence since 1904, when the first pump was installed, and an area of about 100 feddans* brought under cultivation, the work being carried out under the direction of Mr. Hewison.

During the year that followed a considerable extension took place in the area irrigated, and at the present time some 500 feddans of land, immediately adjoining the Section Farm, are carrying a crop of cotton each season.

This area is worked by native cultivators who, in return for the supply of water and for the various administrative services entailed, hand over one-half of their cotton crop to the Government each year.

They are bound by contract to sow only such seed as is supplied by the Department of Agriculture for the purpose.

The whole area is entirely cut off from surrounding cotton-fields either by the full width of the Nile or by open desert, except at the northern extremity, where a comparatively narrow portion abuts on to land watered by a privately-owned pumping plant. It will be seen, therefore, that it constitutes an extremely valuable site for the propagation of new varieties of cotton, and application has been made to effect its complete isolation by controlling or forbidding altogether the cultivation of cotton on the lands to the north.

In the year 1912 the Experimental Farm passed under the control of the Department of Education, and Mr. E. R. Sawyer was appointed as Principal of the Central Research Farm, Shambat, Mr. R. E. Massey being appointed in the same year in the capacity of Economic Botanist.

* 1 feddan = 1.038 acres.

Mr. Sawyer left in 1919, and from that time onwards Mr. Massey, as Government Botanist, has carried on single-handed the duties of plant breeder, physiologist, pathologist, and other functions. The section passed once more under the control of the Department of Agriculture in 1920.

The increasing importance of the cotton crop to the Sudan made it clear that a wider basis of distribution of the work was necessary, and accordingly, in April, 1925, I was appointed by the Empire Cotton Growing Corporation to undertake the duties of Plant Breeder to the Sudan Government, it being understood that work on cotton should take precedence over other crops.

In the agreement under which I was appointed, it was arranged that my duties in the Sudan itself should not commence prior to September, 1925, and, accordingly, on August 30, 1925, I first reported for duty in this country.

On my arrival in August Mr. Massey was, unfortunately, away, and did not return to the Sudan for several months. I was therefore unable to obtain the benefit of a personal handing-over of records, etc., but the work of picking up the threads was rendered much easier owing to the fact that it had been possible for me to make a short preliminary visit to the country in April, 1925.

During this preliminary visit I was able to discuss with Mr. Massey the lines on which the experimental work had previously been conducted, and also to obtain from Mr. Hewison and other officials of the Department of Agriculture a considerable amount of information as to the scope and methods of cotton cultivation in this country.

In addition, I was asked by Mr. Hewison to submit a preliminary report showing what I considered to be necessary in the way of buildings, equipment, and staff for the proposed Plant Breeding Section.

The question of redistribution of work between Mr. Massey and myself, and the transference of a portion of his existing staff, were also discussed.

The general lines on which the work at Shambat has now been reorganized are as follows:

A. *Plant Breeding Section*, under control of the Plant Breeder.

This section undertakes all work in connection with the selection, purification, and propagation of cotton and other established field crops in the Sudan, together with the work of introduction and testing of new strains and varieties of such crops. Arrangements will be made for the testing of varieties, under controlled conditions,

in various parts of the country, in order to ascertain what types are best suited to the different tracts.

The general organization of building and constructional work and the management of the Experimental Farm and staff are considered to come under the Plant Breeder, who will be assisted in the later work by a Farm Manager appointed for that purpose.

The introduction and trial of new kinds of fruit and other trees and of useful and ornamental plants, and the distribution of successful kinds will be continued so far as time and opportunity permit. In this work the two sections will collaborate; the administration, allocation of funds, etc., being undertaken by the Plant Breeder, whilst Mr. Massey, in his capacity of Government Botanist, will continue to give the benefit of his valuable experience and advice, and will remain in personal touch with those concerned.

Various side-issues, arising out of the work of plant breeding, will be dealt with by the Plant Breeder as occasion demands—*e.g.*, developmental studies of the cotton plants at different seasons and periods of growths, etc.

B. Section of Plant Pathology and Physiology, under control of Government Botanist.

This section, under Mr. Massey, will undertake research into the underlying principles which influence the growth and yielding power of cotton and other crops, and their resistance or susceptibility to disease.

The Government Botanist will also continue his systematic work on the flora of the Sudan, and deal with the identification of specimens, etc.

(3) LOCATION OF HEADQUARTERS OF PLANT-BREEDING SECTION.

In their report on the Organization of Scientific Work in the Sudan Sir John Russell and Dr. Martin Leake recommended that the headquarters of the plant-breeding section should be at Shambat, and my preliminary visit to both Shambat and the Gezira Research Farm in April, 1925, demonstrated several advantages in favour of the selection of the former place as a site for the plant-breeding section. Foremost amongst these were (1) its isolation from the main Gezira area, and (2) the fact that there existed at Shambat an area equivalent to about 500 feddans, under cotton annually, of land fully controlled by the Department of Agriculture, where propagation of new varieties could be undertaken without interfering with general arrangements of seed supply for the Gezira and without risk of contamination of seed-stocks.

The existing experimental farm land at Shambat is conveniently situated at the southern extremity of the Shambat pump scheme area, and is itself cut off on the north from the rest of the irrigated area by a forage farm on which berseem only is grown.

It was therefore decided to house the section at Shambat, and to make use of the present experimental farm for the purpose of breeding plots, propagation and preliminary trials.

An arrangement has been come to whereby an official on the staff of the Gezira Research Farm will be able to devote his time to the carrying out of botanical observations in that locality on lines suggested by the Plant Breeder and Government Botanist respectively.

This arrangement is considered to be of the greatest value as it enables simultaneous trials to be made at Shambat and the Gezira Research Farm, and links up the work of the two places.

(4) BUILDINGS.

The existing office and laboratory accommodation at Shambat was quite inadequate to meet the demands of the necessary expansion of work and increase in staff.

Suggestions as to the extra accommodation necessary were put forward by me in my preliminary report to the Director of Agriculture, at his request, and, in the light of further experience, certain additional rooms were included in the scheme on my return in September, 1925.

At the time at which the period dealt with in this report expired, the work was already well in hand, and it was possible to occupy some of the rooms.

The original building, consisting of four rooms only, is being converted into a two-storied building, of which the top story will be handed over to the pathological section, whereas the ground-floor will be occupied by the plant-breeding section.

The accommodation on the ground floor consists of two large rooms, utilized as office and laboratory respectively, a long room with a north light at one end for the sampling and examination of cotton, a room for the farm manager, a room for an assistant plant breeder, and a clerks' office.

One of the later additions to the scheme was a room on the top floor for use as a common library for the two sections.

A useful seed-store with shelves capable of carrying a large number of small seed samples has also been completed during the

period under review, and stands about 50 metres away from the main building.

Approval has been given and plans prepared for the erection of a gin-room (to contain one full-size roller-gin), and of a baling-room alongside it.

The accommodation for the native staff consists at present of a long, low building constructed of mud brick, which has given considerable trouble from white ants, but application has been made for the conversion of this into a permanent burnt brick building, which will both be cooler and allow more space to work in. This building would contain rooms for the routine work of combing of cotton seeds, weighing of single plant samples, and ginning on small 4-inch and 12-inch gins; also stores, etc.

I understand that provisional approval has been given for this work to be put in hand.

In addition, a suitable store, constructed of sheet iron capable of holding about 200 kantars* of seed cotton in small lots and some 150 ardebs of seed, will be urgently required, as soon as our gin comes into operation, as also a "sunning floor" on which seed can be exposed to the sun in order to kill larvæ of the Pink Bollworm.

These have been applied for and are now under consideration, together with a more extended scheme which I have put forward for the provision of dwelling-houses for the British staff and for the reconstruction of the houses now occupied by the Sudanese officials.

(5) STAFF.

The following staff was applied for by me on my arrival in September, 1925, and was approved with effect from January 1, 1926:

CLASSIFIED OFFICIALS.

One Plant Breeder.
One Farm Manager (seconded from Forestry Section).
One Clerk (Grade VII.).
One Computer (Grade VII.).
One Overseer Field Experimental Work (Grade VII.).
One Overseer Laboratory Work and Ginning (Grade VII.).
Two Senior Plant Observers (Grade VIII.).
Three Junior Plant Observers (Special Primary Grade).

UNCLASSIFIED OFFICIALS.

One Farm Foreman.
One Messenger.

DAILY LABOUR.

Wages £ E.640 per annum.

* For definition of kantar see p. 119; 1 ardeb of Egyptian cotton seed weighs approximately 270 lbs.

In December, 1925, I applied for an additional post of assistant plant breeder, and this appointment was approved on February 25, 1926.

The new post was not filled until after the termination of the period under review.

(6) THE EXPERIMENTAL FARM.

The total area of the farm at Shambat is just under 90 feddans (acres), of which some 4 feddans are permanently under trees.

A wide road runs from south to north through the middle of the farm, two-thirds of the cultivable area lying to the east of this road and one-third to the west.

The portion to the east of the road, which is by far the most regular as regards soil, has been reserved for cotton, which will be grown on a three years' rotation fallowed in intervening years, with an occasional leguminous crop when considered necessary.

The area of this land available for cotton each year will be about 22 feddans, and, in addition, a few feddans of cotton will be grown on the western side of the main road, using only the more regular fields. This latter portion of the farm will also be used for the growing of durra, wheat, and other crops.

An area of about 7 feddans will be kept under berseem (lucerne) for providing fodder for the working cattle.

The actual division of area under different crops during the winter 1925-26 was as follows:

Cotton	..	..	..	..	..	25½ feddans
Wheat	..	..	..	..	..	18 "
Berseem	..	..	..	..	..	7½ "
Lubia and cowpea	..	..	..	..	..	2 "
Other crops	..	..	..	..	..	2½ "
Fallow and trees	..	..	..	..	..	34½ "

The farm is well supplied with implements, and a Fordson tractor is included in the equipment.

Native labour is often none too easy to get, especially during the rains when durra sowing is in progress.

The men work slowly and need constant supervision, their lack of industry being in sharp contrast to that of the Egyptian fellaheen.

Cotton picking is done by women and children at the rate of about 2 milliemmes* per pound of seed cotton. Each picker will gather about 15 to 20 lbs. per day on the average, though considerably more can be picked when the trees are heavily loaded.

The picking is done carefully, and the resulting cotton is usually clean.

* 1 millieme = approximately 1 farthing.

(7) SOIL AND CLIMATE.

The following figures, representing the normals for the years 1913-1920, taken from the *Climatological Normals*, published by the Physical Department of the Egyptian Ministry of Public Works, may usefully be repeated here as indicating the conditions of temperature and humidity that occur in this region (Shambat Research Farm).

TEMPERATURE (CENTIGRADE).

		Average (Maximum).	Average (Minimum).	Mean of Day.	Hottest Day.	Coldest Day.	Relative Humid- ity (per Cent.), 8.0 a.m.
January	..	31.0	14.4	22.7	38.3	6.0	54
February	..	32.8	14.8	23.7	40.5	9.0	50
March	..	36.3	18.0	27.1	48.0	8.5	45
April ..	..	39.5	20.4	30.0	44.5	10.5	38
May ..	..	41.0	23.2	32.1	48.0	14.4	40
June ..	..	40.4	23.9	32.1	46.0	15.3	50
July ..	..	38.5	24.5	31.5	43.0	18.3	53
August	..	37.2	23.9	30.6	43.0	12.2	63
September	..	38.5	24.5	31.5	43.0	15.6	58
October	..	38.7	22.9	30.8	44.4	15.6	48
November	..	35.6	19.2	27.4	43.0	11.7	47
December	..	30.8	15.3	22.9	39.4	1.7	52

The chief characteristics are the very high average maximum temperatures which prevail from April to October and the very low humidity (taken at 8 a.m.) in all months except August and September.

The annual rainfall is very slight (about 5 inches), and is almost restricted to the months June to September. Air temperatures drop considerably after a fall of rain in the neighbourhood, and humidity naturally rises, otherwise rain is for the most part a nuisance, as it interferes with the sowing of cotton and encourages the growth of weeds. After very heavy rains, large portions of the farm are liable to remain flooded for some days, owing to the impermeability of the soil.

As regards soil, the farm shows a considerable range of type.

It consists of an alluvial deposit of long standing, and comes under the local generic classification of "Karu." Its composition varies considerably in different parts of the farm, the irregularities being particularly marked on the western side of the farm, near the river. As explained in the preceding section, cotton work will be

almost restricted to the eastern portion, and here the soil consists for the most part of a light-coloured loam containing a rather high percentage of clay and fine silt, and very little humus.

After prolonged fallowing the surface layers work up moderately readily into a fair tilth, but when a few irrigations have been given it becomes very impermeable, and, on drying, large cracks are formed.

Mechanical analyses, made by the Government chemist in 1920, on samples taken from this portion of the farm, are summarized below:

<i>Place where Sample was Taken.</i>	<i>Fraction.</i>	<i>First Foot.</i>	<i>Second Foot.</i>	<i>Third Foot.</i>	<i>Fourth Foot.</i>
		<i>Per. Cent.</i>	<i>Per Cent.</i>	<i>Per Cent.</i>	<i>Per Cent.</i>
Hosh 2, Fedd 1	Coarse and fine sand	41.8	65.9	—	—
	Silt	34.8	8.6	—	—
	Clay	22.7	22.8	—	—
Hosh 4, Fedd 1	Coarse and fine sand	38.9	38	36.4	—
	Silt	10.2	12.6	13.2	—
	Clay	48.4	47.4	48.2	—
Hosh 4, Fedd 2	Coarse and fine sand	62.6	41.7	40.5	—
	Silt	11.3	10.1	7.3	—
	Clay	25.4	46.4	49.3	—
Hosh 8, Fedd 1	Coarse and fine sand	43.6	43.5	36.5	44.6
	Silt	11.8	11.3	14.9	14.5
	Clay	44.5	45.3	48.5	40.4
Hosh 12, Fedd 7	Coarse and fine sand	40.2	37.0	42.3	—
	Silt	11.2	13.7	13.7	—
	Clay	47.9	49.3	44.1	—
Hosh 12, Fedd 8	Coarse and fine sand	39.6	39.9	35.3	—
	Silt	13.6	13.2	11.5	—
	Clay	46.5	47.0	53.5	—

It will be seen that, in general, the proportion of clay comes out at between 45 and 50 per cent., with local irregularities resulting in percentages as low as 25.4 and as high as 53.5.

There is a general tendency for the upper soil to get heavier as one passes down from the surface layer, and a zone of low permeability often exists in the second and third feet.

Not much information is at present available as to the nature of the still deeper layers of the soil in this part of the farm, but it would appear that, on the whole, it is considerably lighter, though the point at which the change in this direction takes place probably

varies considerably. In the case of one hole, 11 feet deep, which was dug in 1923 (Hosh 2, N.W. corner), the percentage of clay began to fall away rapidly after the fourth foot, and at 8 feet the amount of coarse and fine sand had risen to 68 per cent. It should be noted, however, that in this particular place the surface layers were considerably lighter than normal.

Another hole, excavated in 1921 to a depth of 16 feet in a place where the surface soil showed a more typical clay content (44.1 per cent.), gave increasing proportions of clay up to the fifth foot, where 57.9 per cent. was reached and the soil still remained heavy till the eighth foot was passed, when the proportion of clay dropped suddenly from 38.9 to 18.7 per cent.

The soil is all distinctly alkaline, the pH value on samples so far examined by the Government chemist coming out between 8.3 and 9.1. The samples all refer to the top first or second foot. Arrangements are being made for extending the series of records on pH values and on percentage of soluble salts present. Very little information is at present available on the subject of salt content since 1923, when new improved methods of determination were introduced by the Government chemist. Individual determinations, however, show a range of from 0.05 to 0.88 per cent. in the first 2 feet, so that considerable irregularity may be expected.

The amount of nitrates present in the soil varies with the time of year, but is distinctly low throughout, and nitrogenous manures have been found to give good results in practically all cases.

It is important to consider the state of the soil and climate at Shambat in relation to the conditions which obtain in the principal cotton-growing areas of the Sudan.

The Tokar and Kassala districts are comparatively small, and must of necessity remain so. They need not, therefore, be considered in this case. The same may be said of the riverain lands north of Khartoum, which are watered by pumps, or sagias. The two principal areas are the Gezira tract and the rain lands of the south.

Naturally no useful comparison can be drawn in the matter of climate between areas where cotton depends solely on rainfall and those, such as Shambat, where irrigation is all-important.

In the rain-cotton zone the mean maximum temperature during the growing period is, on the average, about 6° C. below that which occurs during the corresponding season at Shambat. Later, whilst the crop is being picked, it rises to about 4° C. to 5° C. above that at Shambat.

The soils of the rain-zone naturally vary very much, but the

greater part of the cotton is grown on "Badobe" (black "cotton soil"), which is of similar character to that which occurs in the Gezira area (see below).

One common feature of practically all Sudan soils is their alkalinity, and in this, at any rate, Shambat is representative.

The comparison between Shambat and the Gezira area is naturally much closer. The mean temperature for the months July to September is about 2° C. higher, and during the months November to March about 2° C. lower at Shambat than at the Gezira Research Farm. The mean minimum temperatures vary in the same way, but to an even less extent. The humidity at Shambat is similar to that in the Gezira from July to October, but in the subsequent months, though low, it remains rather higher than in the Gezira.

The average rainfall at the Gezira Research Farm is higher than at Shambat, amounting to about 16 inches in the period April to October. As regards soil, the two places show certain similarities in that in each case continued irrigation leads to impermeability, and the soil on drying out cracks very deeply.

The portion of clay is even higher in the Gezira Farm soil, the average being in the neighbourhood of 57 per cent. for the top 4 feet. The same tendency for the clay content to increase with depth up to a certain point is shown at both places, and the change in the opposite direction takes place at approximately the same level—*i.e.*, about 4 or 5 feet from the surface. The change is, however, not nearly so abrupt in the case of the Gezira Farm, and really sandy soil does not occur until a much greater depth has been reached.

The two soils are almost equally alkaline, and both are very deficient in organic matter.

It is not possible to say as yet whether Shambat agrees with the Gezira Farm in showing a maximum concentration of soluble salts in about the fourth foot from the surface, but there are certainly indications to that effect.

PART II.—EXPERIMENTAL WORK, ETC.

(1) INSPECTION OF COTTON AREAS.

During the past season it has not been possible to spend the time necessary to visit more than a few of the more accessible cotton areas.

It is hoped, during the next few seasons, to cover some portion at any rate of each of the main cotton-growing districts in the country.

(A) *The Gezira*.—Several visits were paid to the Gezira Research Farm and to the Sudan Plantations Syndicate's Seed Farm at Barakat.

The crop at these places was seen at various times of the year, and the sharp contrast in the growth-habit between Sakel grown in the Gezira and Sakel grown in Egypt was noted. The most striking difference lies in the suppression of fruiting branches on the lower portion of the main stem.

The Sudan plant rarely manages to produce a fruiting branch lower down than the thirteenth leaf axil of the stem, and often remains bare as far up as the twentieth axil.

The same variety grown in the Egyptian Delta normally bears strong, healthy, fruiting branches from the seventh node upwards.

From six to thirteen potential fruiting branches are thus lost and much energy wasted that should have gone to crop production.

In a paper which I read before a Conference at Wad Medani on soil problems, I was inclined to attribute this inhibition of early branches to soil conditions rather than to temperature effects, but evidence since obtained points rather clearly to the effect being due directly to excessively high temperature (see Section 5 below).

Another interesting difference in the behaviour of the crop in the Gezira as compared with Egypt lies in the mode of "arrival" of the crop. In Egypt, as is well known, it is usual to take two comparatively large pickings, and two only. In the Gezira up to nine or more pickings are taken with very short intervals between.

In consequence of this I found a very general impression in this country that the crop in Egypt opened in two "flushes" with a pause in between. This is not the case, and, in actual fact, the crop opens more steadily and regularly in Egypt than in the Sudan.

The difference in behaviour is due, firstly, to the fact that the very low humidity in the Sudan causes bolls, once ripened, to open very quickly, thus allowing the cotton to be blown to the ground, and, secondly, to the fact that the comparatively low temperatures experienced in the Gezira during December to February result in a considerable prolongation of the maturation period of individual bolls.

The crop in consequence "arrives" more slowly, and the total picking period is much drawn out. In Egypt a prolongation of this nature would probably result in the loss of about half the crop from Pink Bollworm, but this pest is fortunately not so serious in this country.

As illustrating the difference between the two crops in the above

respects, it may be stated that bolls of Sakel in Egypt will retain their cotton for more than four weeks after opening, whereas in the Gezira loss may occur after about ten days. In Egypt the maturation period of a boll of Sakel cotton remains very constantly at about fifty days, but in the Gezira, as shown by the records compiled by Mr. Lambert, the period varies from about forty days during the hottest period to seventy days during the coldest period of the season.

Plants of the same variety growing at Shambat behaved in a precisely similar manner to those seen in the Gezira.

The relation of such widely fluctuating boll-maturation periods to the quality of the cotton contained in the bolls is obviously a matter of the greatest importance.

Evidence already collected by Mr. Massey and Mr. Lambert shows that there is a considerable falling off in length of cotton fibre from bolls opening during the hot days at the end of the season. It is hoped that more information will shortly be available on this subject.

(B) *Tokar*.—A short visit to Tokar undertaken in early January, 1926, provided some further interesting comparisons with the Gezira crop.

The bulk of the crop, which consisted entirely of Sakel, had been sown during September, and was almost as leggy as that at Shambat and in the Gezira. The leaves, also, were scorched and twisted by the hot winds in a similar manner to that noted in other localities, but such of the crop as was growing on land that had received a sufficiency of water was distinctly more vigorous than most of that seen in the Gezira area.

A small area at Sallabat, about ten miles east of Tokar town, had been sown in late October on a late flood from the foothills, and, when seen, was exceptionally healthy.

This portion of the crop had escaped the end of the last hot season and was in perfect condition, except that the plants were actually too soft and full of sap. Fruiting branches were being freely produced as low as the seventh or eighth leaf axil (as in Egypt), and scorching and shedding were practically absent.

Through the kindness of Mr. A. P. Thompson, Inspector of Agriculture, I was enabled to become acquainted with the system on which cotton-growing in the district is organized, and also to visit personally a considerable portion of the area under cotton. I was particularly interested in the question of the utilization of the Tokar area as a propagation area for seed for the Gezira. For

this purpose it would appear to be a specially suitable area on account of (1) its isolation, (2) the absence of Black-arm, and (3) the observed additional vigour of the seedlings grown in the Gezira from seed obtained from Tokar. The disadvantages from this point of view lie in the conditions, at present uncontrollable, under which the crop is grown. The crop depends for its water supply on the water left in the soil by the annual flood of the Baraka River, which flows in intermittent flushes during the months July and August, and on a scanty winter rainfall of about 6 inches.

The area watered by the flood varies enormously from year to year both in position and extent. In the past season a total of 14,000 feddans only was under cotton, and much of this crop subsequently perished from drought.

The average is about 30,000 feddans, but in exceptional years the total may exceed more than three or four times this amount.

This constant shifting of situation and area would seem to preclude any possibility of establishing definite roguing areas, or of arranging other crop improvement work for which it is necessary to make plans in advance. Furthermore, the changing flood makes any attempt at rotational areas impossible, and leaves one open to the danger of contamination of crop from volunteer plants self-sown from the previous year's crop. I made a search for such volunteer plants, whilst at Tokar, but was unable to obtain any clear evidence of their existence. It should not, however, be assumed from this that they do not survive.

Further reference to the utilization of Tokar as a seed-farm area will be found in Appendix A.

About 3,000 feddans out of the total area at Tokar was sown with seed supplied by Mr. Massey from Shambat.

This cotton will be referred to again later when dealing with the Shambat main crop [see Section 2 (*a*) *seq.*].

The rest of the area was under the Tokar Strain of Sakel, a type which has already achieved a considerable reputation. The seed stock is, however, very much mixed, and contains a high proportion of both naked and completely fuzzy seeds, the commonest rogue in the plots being more of the type of the "Hindi weed" than of that of the American hybrid.

(C) *Government Pump Stations*.—Excluding Shambat, there are seven of these stations situated along the banks of the Nile, north of Khartoum, in Berber and Dongola Provinces.

I was able to visit three only during the past season—namely, Gendettu, Bouga, and Mikeilab.

The type of cotton grown is American Upland, and the bulk of the crop is what is known as " Pump Scheme Strain," which originated, in part at least, from an introduction of " Nyasaland Upland " seed, which was first grown at Zeidab. As might be expected, the crop is extremely impure, but the general vigour of the crop cannot be doubted, and the quality is well spoken of by buyers in Lancashire. Yields of up to 7 large kantars* of seed-cotton per feddan are occasionally obtained, with an average of 3 to 4 kantars.

This crop offers a most promising field for selection work.

The total area of land under Government-owned pumps each year (excluding Shambat) amounts to about 5,000 feddans. A similar area of about the same extent is worked by the Sudan Plantations Syndicate at Zeidab, and the importance of these areas as controlled seed-propagation centres, for the production of a pure seed supply for the rain areas in the south, needs particular emphasis (see also Appendix A).

(D) *Rain-Cotton Area*.—In early October, 1925, I paid a very short visit to Makwar, proceeding thence by car to Singa, in Fung Province. Singa may be regarded as being on the fringe of the rain-zone in that direction. About three miles from the town is a small experimental farm, worked under the supervision of the Inspector of Agriculture.

The land on which the farm is situated is very level, and is typical black " cotton soil " (Badobe).

At the time of my visit the cotton had not yet come into flower, but the crop appeared to be coming on nicely, the stand being excellent. Small plots of some six different types of American Upland had been sown, all of which looked promising. Rain was still falling locally at the time of my visit, but the quantity was not sufficient to pull the crop through, and the yield in the end was practically negligible.

The area would seem to be an excellent site for a cotton variety testing station, representing, *in a normal year*, the lightest rain conditions possible for the successful growth of the crop.

It is hoped to make use of the farm for this purpose in the coming season.

* The " large kantar " equals 315 rottles, and is used exclusively in reference to seed-cotton. The " small kantar " (100 rottles) is used equally freely in this country for either seed-cotton or ginned lint.

A " rattle " is equal to 0.99 pound.

(2) MATERIAL AVAILABLE.

As explained in the introductory portion of this report, Mr. Massey had been engaged in cotton-breeding work for several years previous to the season under consideration. During that period he had introduced a number of types into the Sudan, and had carried out selection work on many of these. The stock from these, together with a certain number of fresh introductions from Egypt and the United States, constituted the material available for this season's work. Most of this material was concentrated at Shambat or Halfya Meluk, a village situated about three miles north of Shambat and watered by the same pump.

In addition, as stated in a previous section, there appear to be great possibilities for straightforward selection in the present "Pump Scheme Strain" of American cotton, grown on the Government pump lands.

(a) *Shambat Main Crop*.—This cotton is derived from a consignment of seed of Domains Sakel, received from Egypt in 1922. Both single-plant selection and negative bulk selection were practised on the plants growing in 1923, and the stock of seed resulting from the latter process has now been worked up into a supply which has been sufficient to sow the whole of the Shambat Halfya pump lands (about 500 feddans), as well as the bulk crop of the Shambat Experimental Farm and about 3,000 feddans at Tokar.

This type of cotton, which is now referred to as "Shambat Sakel" or, more explicitly, "Massey's Selected Sakel," shows the usual characteristics of Sakel in this country—legginess and susceptibility to damage by hot winds, etc., and, when seen in the field, its appearance does not produce a very favourable impression. Its yield is, however, satisfactory, and the average of the whole area at Shambat-Halfya came out at $2\frac{3}{4}$ large kantars per feddan, including poor land.

The quality of this cotton, too, has been very favourably commented on in England. Three samples sent from this year's Shambat crop to the British Cotton Growing Association were reported on as follows:

First Sample.—Staple fine, long and strong, a little wasty (graded as "about fine"). Nominal value 18·75 pence per lb.

Second Sample.—Staple fine, medium length, and strong (graded as "fully good to fine"). Nominal value 18·50 pence per lb.

Third Sample.—Staple fine, rather wanting in length, and wasty (graded as "strict good"). Nominal value 18·00 pence per lb.

The above report was compiled on April 26, on which date Sakel F.G.F. (May) was standing at 15·10 pence per lb. and Fine Sakel at 18·25.

Later, on June 8, 1926, thirty-eight bales, corresponding to the first and second samples shown above, were sold by Messrs. Wolstenholme and Holland at a price of 21·75 pence per lb. The grade on which it was sold is not stated, but by inference from the previous valuation report it may be said that the price paid represented a premium of about 200 points on for Sakel of the same grade.

Reports of other sales are not yet to hand, except in the case of the cotton of the same strain which was grown at Tokar. This cotton was sold locally at the Tokar cotton market, when the price per small kantar of 100 lbs. seed-cotton came out at 173 piastres, on the average, for a quantity exceeding 600 kantars. The local strain of Tokar Sakel was sold at about 20 piastres more per kantar during the same auction.

The Inspector of Agriculture, Tokar, in commenting on this, remarks that the difference in price was due to the newer type lacking the special lustre and "feel" that characterizes Tokar cotton. This character is said to develop after one or two seasons' growth in the district. It is possible, also, that the buyers were to some extent influenced in this case by the *name* of the Tokar crop.

The purity of the Shambat strain as grown on the Experimental Farm at Shambat was entirely satisfactory, but a certain number of rogues have been noticed in the main crop. These are presumably volunteer plants from previous sowings, and should disappear in a few years with the institution of a special roguing area situated within the Shambat Pump Scheme.

(b) *Types available at Shambat Research Farm.*—Before my arrival, the following different plots of cotton had been sown for me at Shambat, through the kindness of Mr. Massey.

1. *A Variety Strip Plot.*—This consisted of a long narrow area of 7 feddans, divided into a series of thirty-five strips, each 100 metres long and 8 metres wide (about $\frac{1}{5}$ feddan).

The strips were numbered in order from 1 to 35, and all the odd numbered strips were sown with the standard "Shambat Sakel." The strips with even numbers were sown with a number of different types. The layout of the plot was governed by convenience, and the results are incapable of statistical treatment, as no variety except the control type was repeated more than once. Some indications as to yielding power can, however, be obtained by comparing the yield of each kind with the mean of the yields of the control plots on either side.

The figures obtained in this way are given below, but it should be noted that the stand in some cases was extremely patchy, especially in some of the lots newly introduced from Egypt. This patchiness did not occur in the control type, and the results in consequence are apt to be misleading.

<i>Strip No.</i>	<i>Variety Name.</i>	<i>Comparative Yield Expressed in Rottles + or - , the Average of Two Control Plots Alongside.</i>	<i>Notes as to Stand of Plants, and other Irregularities.</i>	<i>Notes as to Earliness, etc.</i>
2	Sakel B/24	+21	Stand satisfactory	Similar to control.
4	Sakel C/24	-18	" "	" "
6	Sakel Bolland 19	+24	Stand satisfactory (probably slightly favoured by soil)	Rather " later " than control.
8	Sakel Bolland 8	+27	Stand satisfactory (probably slightly favoured by soil)	Rather early.
10	Sakel Bolland 5	-26	Stand satisfactory	Late.
12	Sakel 176/10	+7	" "	Latish.
14	Sakel 186/12	-7	Stand satisfactory (probably slightly penalized by soil)	Similar to control.
16	Sakel 186/24	-8	Stand satisfactory	" "
18	Ashmuni C/24	+40	Stand fairly satisfactory	Much " earlier " than control.
20	N.T. 19/24	+29	Stand fairly satisfactory	Much earlier than control.
22	N.T. 25/24	-18	Stand fairly satisfactory	Much earlier than control.
24	Nahdah	-12	Stand patchy	Similar to control.
26	Camli A/23	-8	Stand very patchy	" "
28	Pelion A/23	+19	" "	Rather early.
30	Garofallou A/3	+1	Stand fairly satisfactory	Similar to control.
32	310 A/23	-5	Stand fairly satisfactory	" "
34	Sea Island Sakel Cross	-1	Plants all so stunted by ground as to make result valueless	" "

As regards the types detailed in the above table, those in strips Nos. 6, 8, 10, 12, 14, and 16 all represented types of Sakel Selected by Mr. Massey.

The types referred to as " Bolland Sakel " were all derived from single plants selected in 1922 from a bulk crop of a strain of Sakel introduced from Egypt in 1919, where the strain had originated some five years earlier from a single plant selection made by Mr. Bolland.

Some of these showed vegetative vigour distinctly superior to the standard type, and I understand that this characteristic has been noted in previous seasons.

The Sakel strains denoted by 176/10 and 186/12 and 186/24 originated from single plants selected in 1922 and 1923 respectively from fields of types "176" and "186" growing at Shambat. The original "176" was itself selected in the season 1919-20 by Mr. Massey from a crop of Sakel at Shambat derived from a stock the seed of which was supplied by the Ministry of Agriculture, Egypt, in 1913. This, I understand, was the first introduction of Sakel into the country. Sakel "186" was also a single plant selection from the field crop Sakel growing on the Gezira Research Farm in 1919.

The remaining varieties shown in the table are all fresh introductions kindly supplied by the botanical section of the Ministry of Agriculture of Egypt.

No specially interesting feature need be recorded as regards vegetative development, but the yield shown by Pelion from an extremely patchy plot is interesting.

The types shown as "Ashmuni C/24," "N.T. 19/24," and "N.T. 25/24" are all Upper Egyptian types, and were nearly three weeks earlier than the standard Sakel. The two first have given indication of excellent yields, but experience has shown that, where Black-arm is prevalent, Upper Egyptian types are very badly affected. A comparatively large area, sown at Barakat this season with seed of the Upper Egyptian varieties newly imported from Egypt, was reduced to a condition of leaflessness, and the stems and bolls almost entirely blackened by this disease.

The result given by Nahdah in this plot is disappointing in view of the favourable results obtained in the Gezira this season.

New selections have been made from a number of the varieties in this plot, and the results obtained have been used as an assistance in deciding on the types which should be tested by the "Replicated Strip" method in future seasons.

2. *Observation Plot (Small Lots of Bulkcd Seed).*—This plot contained small beds, $\frac{1}{10}$ feddan in area, of certain types of Sakel and Sea Island and a single strain of Afifi which Mr. Massey considered sufficiently interesting to merit further trial.

The Sakel types, of which there were three in this plot, were all derived from Bolland Sakel No. 19, which was also represented in the Variety Strip plot just discussed. All three types in this case were very "leggy," but one, No. 19.3, showed rather more vigour than average Sakel.

Eight types of Sea Island were represented in the plot—namely, Sea Island A 7.1., A 27, B 7.5, B 7.6, C 2.3, D 14.1, D 1.8, and D 3.2.

The letters A, B, C, and D in the above list refer to four single-plant seed samples sent by Dr. S. C. Harland from St. Vincent in 1921, and first grown here in the season 1921-22.

The original numbers (as sent by Dr. Harland) were:

U.S. 3 =A

H. 23.15=B

V. 18.24=C

V. 135.4=D

Selfing was carried out in each of these lines for two or three years, when it was decided that the deterioration in the quality of the lint was such as to make it unlikely that any useful result would be obtained from this type.

The plants were therefore left unprotected for a season, and considerable outcrossing took place.

A general type, however, persisted in each case, and the plants were extremely interesting in their unexpected tolerance of the climate.

Taken as a whole, the plants were more vigorous and far less "leggy" than the Sakels alongside. Many of them were distinctly fruitful, but the bolls in a large number of cases failed to open in the proper manner. Frequently the boll hardened off before dehiscing and the cotton contained in the bolls was discoloured and scanty. This faulty opening appears to be a feature of Sea Island cotton in this country, and severely offsets the natural vigour of growth of the plant itself.

Judged as Sea Island, the lint from these imported strains is a failure. Halo length measurements were made on a number of seeds of each type, and it was found that the average length was between 31.7 mm. and 35.7 mm., which is about 10 mm. less than the length recorded for the original parent plants, and places them on a par with average Sakel cotton in this country.

Determinations of hair weight per centimetre carried out by Dr. Balls at Bollington on some material supplied by Mr. Massey showed a similar great loss in fineness also.

It is clear that Sea Island cotton, as known to the market, cannot be produced in this country, but the vigour manifested by the plant at Shambat encourages one to regard this kind as a promising field for selection and hybridization.

A combination of Sea Island vigour and Sakel type lint might be expected to produce very useful results.

The remaining bed in this plot was sown with a selected strain of Afifi cotton, which has been continued here in case a demand should arise for an early cotton of this type.

The detailed figures for yields from these beds have no statistical significance and are, therefore, not given here.

The best yielding types appeared, however, to be the Sea Island types A 27, D 18, and D 3.2, and the Afifi (No. 143.7.9).

The most satisfactory strain of Sea Island, as regards purity, vegetative vigour, and normal boll-opening, was S.I. D 1.8.

Certain of the types in this plot along with others from the Variety Strip Plot will be given a trial next season in a "Preliminary Replicated Strip Test" at Shambat.

A number of new selections were made, especially amongst the Sea Island beds. These will be tried out in line-breeding next season.

Lint from all types in this observation plot as well as from all pickings of all types in the Variety Strip plot was examined in the laboratory. As a result of this examination, and taking into consideration the information obtained in the field, it has been decided to discontinue a number of types. Five-pound lint samples, taken from second and third pickings of the "survivors," have been made up, and it was originally intended to select some of these for spinning tests. In view, however, of the fact that the ginning has in all cases been done on a 12-inch gin, and that no baling press is as yet available, it has been decided to wait until another season's crop has been dealt with in a manner more approaching standard practice.

Sea Island D 1.8 was one of the most satisfactory of the Sea Islands as regards quality, and gave a halo length, on twenty "sub-basal" seeds, of 35.1 mm. S.I. A 27 and S.I. D 3.2 also gave satisfactory results, judged on a "Sakel basis."

In the case of the Sakels, the type known as "Bolland 8" was found to be decidedly on the low side as regards quality, which is unfortunate in view of its apparent yielding power. "Bolland 19.3," which had given rather encouraging results in the field in the Observation Plot, was noted to be a great improvement in respect of lint quality.

In pulled staple all the Sakels fell within the limits of $1\frac{1}{2}$ to $1\frac{5}{8}$ inches, the higher value being reached only by "Sakel 186/24" and "Bolland 19.3."

The Upper Egyptian types examined ranged from $1\frac{1}{4}$ to $1\frac{3}{8}$ inches.

3. *Pedigree Lines*.—A total of 126 families raised from seed of single plants was grown this year at Shambat.

The types represented by these families were as follows:

Bolland's Sakel	28 families.
Sakel 176	7 "
Sakel 186	15 "
Massey Selected Domains Sakel	12 "
Two different new types of Sakel (characterized by extra long lint) from Giza, Egypt (new introduction)	10 "
Assiloid Sakel from Giza (new introduction)	6 "
A good yielding type selected at Giza from Balls' "310" (new introduction)	8 "
Sea Island "A"	12 "
" " "B"	5 "
" " "D"	6 "
Two types of Sea Island, newly introduced from Egypt, known respectively as "Damietta Sea Island" and "Giza Sea Island"	14 "
Affi 143/7	3 "

Of the above, the new introductions were for the most part disappointing. The "long" Sakels failed to reach more than average length (which in this plot was 31.2 mm. only), and the "Assiloid Sakel," which was expected to be "resistant" to shedding, showed a high degree of shedding and was similarly affected as regards lint length.

The families grown from seed of Sakel types which had been in the country for some years were also for the most part leggy and typical in the way that they reflected the ill-effects of their environment. One family derived from "Bolland Sakel" showed a certain amount of vigour, and certain families from "Domains Sakel" stock produced halo measurements of 34 mm.

The Sea Island families were much the most interesting, and their vegetative vigour was clearly demonstrated. The yield which they might have been expected to produce was, however, very much curtailed by their characteristic failure to open their bolls normally. A certain amount of variability was noted in this direction, and special attention was paid to the point in selection.

The average halo length of those Sea Island families grown in this plot which were examined in detail came out at 32.3 mm. Occasional plants were found which retained something of their normal length.

Preliminary selections were made in the field amongst all these families, and arrangements made for the selfing of flowers and the picking of each of the selected plants separately.

A subsequent examination was made in the laboratory in the case of selected families. The nature of this examination is explained in the section dealing with Methods (see later).

On the results obtained final selections were made for carrying on in the coming season, the totals selected being as follows:

Bolland Sakel	..	..	..	..	..	..	3 plants.
Sakel 176	..	..	..	..	..	..	1 plant.
„ 186	..	..	..	..	..	..	1 „
Domains Sakel	..	..	..	..	..	..	3 plants.
Giza Sakel	..	..	..	..	..	..	1 plant.
Assiloid Sakel	..	..	..	..	..	..	1 „
Afifi 143	..	..	..	..	..	..	1 „
Sea Island "A"	..	..	..	..	..	..	2 plants.
„ "B"	..	..	..	..	..	..	2 „
„ "D"	..	..	..	..	..	..	4 „
"Damietta" Sea Island	..	..	..	..	..	..	2 „

In addition to the above, new "first" selections were made of a number of single plants in families which had shown themselves to be markedly impure.

4. *Hybrids and their Derivatives.*—Mr. Massey having informed me that he had had some promising results with crosses made between Sakel and Sea Island types, I was able to obtain from the botanical section in Egypt the seed of some fifty F.2 plants from a cross made there in 1922 between a Sakel and one of Dr. Harland's pure line Sea Islands.

The F.3 generation was sown at Shambat, and several of the families were found to have arrived at something approaching purity as regards habit. Some of the families showed new features not noted in either of the parent plants—*e.g.*, family 163/25 bred out pure for extremely long sympodia with a remarkably high number of nodes. The plants were very fruitful, but the bolls opened as badly as in the case of the pure Sea Islands.

None of the F.3 families which were examined exceeded a halo-length of 35 mm., and the lint in some cases (*e.g.*, families 148/25 and 163/25) was distinctly brown in colour.

Family 148/25 was also notable for the excessive production of short monopodial shoots, which arose from all axils of the lower two-thirds of the stem. This character had also reached the "fixed" stage.

An F.2 from a cross made by Mr. Massey also gave an interesting range of types, as did another family which had come from a natural vicinist.

Further plants were taken from the more interesting families referred to above, and self-bred seed obtained from sowing next year. The laboratory examination of the plants was conducted on the same lines as in the case of the pedigree line families. Twenty-nine plants were finally selected.

(c) *Types available at Variety Observation Plot at Halfya Meluk.*
 —An area of 3 feddans had been sown for me at Halfya Meluk. The varieties sown were all American, and suitable precautions were taken to avoid using the seed from surrounding areas of Sakel for sowing purposes in the coming season. All the types sown in this plot had either been introduced into the country by Mr. Massey or selected by him from the Pump Scheme Strain.

Of the introduced types, some had been subjected to further selection, whilst others had not. The following table gives the list of types and an indication of their origin:

<i>Variety.</i>	<i>Strain.</i>	<i>Origin.</i>
Meade	C C 1 C 2 C 3 D	Original Meade seed introduced by Mr. Massey in 1922. Types C and D (amongst others) were selected by him as single plants in 1922-23 and selfed. Further single plant selection made from C in 1923-24 gave types C 1, C 2, and C 3. The plot of "C" this year was raised from self-bred seed. The other types were from natural seed.
Columbia	No. 44	Variety first introduced in 1922. The present strain is descended from one plant selected from bulk in 1922-23 by Mr. Massey and selfed.
Delta Webber ..	1 B.S. 1 (Bouga) 2 B.S. 2 (Bouga)	Two strains of Delta Webber (Nos. 1 and 2) were introduced in 1924. Some plants of each of these two types were raised at Shambat in 1924-25, and some at Bouga. All seed from Shambat (marked "B.S.") was self-bred, Bouga seed being "natural."
Pedigree Webber..	—	Introduced from U.S.A. as such in 1923-24. Grown on in bulk.
Gendettu	No. 13	From a single plant selected at Gendettu in 1922-23 from Pump Scheme Strain. Grown on in bulk since 1923-24.
Hanik	No. 140	From a single plant selected at Hanik in 1923-24 from Pump Scheme Strain. Grown on in bulk since 1924-25.
Lightning Express..	1 2 3	Three separate strains introduced from U.S.A. in 1924. The present lots were grown from bulked self-bred seed from plants at Shambat in 1924-25.
Acala	—	Seed introduced from U.S.A. in 1924. Present lot grown from bulked self-bred seed from plants at Shambat in 1924-25.
Lone Star	—	Ditto.
Durango	—	Ditto.
Cleveland	No. 3	Introduced from U.S.A. in 1922. Plant No. 3 selected in 1922-23 and selfed, gave rise to present strain.
Pedigree Dixie ..	—	Introduced from U.S.A. in 1923-24. Grown on in bulk.

The plot as a whole did extremely well and produced an excellent crop despite the fact that it was sown on August 7, which is considered to be late in this district. The total yield, all varieties taken together, worked out at just under 6 kantars per feddan. The field was remarkably free from irregularity and allowed of tentative deductions on yield, earliness, etc., being drawn, which would otherwise have been impossible.

Each type occupied an area of $\frac{1}{7}$ feddan, and all were apparently pure for habit characters except Meade D, Pedigree Webber, and Pedigree Dixie. All the Meade strains were impure for lint and fuzz characters.

The following inferences were drawn from the yields obtained from this plot:

All the Meades tried are low yielders, and very late. Individual plants appear to be able to keep up the length and quality of their staple, which in some instances was up to $1\frac{9}{16}$ inches.

Of the "normal" long-stapled kinds, Columbia is the most attractive as regards lint quality and length, but in lateness it rather resembles Meade, and it appears to lodge rather badly.

The Delta Webbers form one of the most promising types, as, though the total yield is not extremely high, the first crop comes in very early indeed, and the lint is of excellent quality. Furthermore, the plants are low and compact, and do not lodge in spite of the large bolls which they bear. The two strains of Delta Webber appear to be very similar.

Both the "Gendettu" and "Hanik" selections did very well as regards yield, and the former topped the list in this respect.

Both have lint nearly as long as Delta Webber, but not of such good quality.

"Gendettu" is fairly early, as well as being fruitful. It has an open straggly habit, but does not lodge. The "Hanik" type yields well, but is distinctly later than the foregoing, and is very tall and lodges badly.

The three strains of Lightning Express tried did not show much promise. The final yield was high, but from one-half to one-third of the crop only arrived after the crop had been in the ground for about seven months. Under normal "rain" conditions this "second crop" would never arrive at all.

Durango showed little promise in this trial, and both Acala and Lone Star, though producing a crop of above average size, tended to behave in a manner similar to Lightning Express.

The plot of Pedigree Webber was, as stated above, very far from pure, but obviously contained a fair proportion of early plants.

The two remaining varieties—Cleveland and Pedigree Dixie—are both on a lower level as regards staple, compared with any of the foregoing. Both pulled at about $1\frac{1}{2}$ inches. Both were distinctly early and gave good crops, but they tend to lodge badly, more especially Pedigree Dixie, which, however, is superior both in yield and staple to the other type.

In every bed ten typical plants were chosen and selfed, and determinations made on these of halo length, lint index, boll maturation, etc.

In addition a number of specially early, healthy, and high-yielding plants were chosen as “new selections.”

(3) OUTLINE OF METHODS EMPLOYED IN SECTION.

Plenty of material exists at the present time in the Sudan from which new single-plant selections can be made.

Any lots of seed obtained from such sources are sown plant-to-row in immediately adjacent rows, as allowing of rapid examination and comparison in the field. They are referred to as “*New Selections*.”

Field records are kept on these rows, and, as early as possible, any families which fail to show the special feature for which the parent plant was selected, or which show themselves to be “splitting,” are scrapped. In certain cases a re-selection of “*New Selections*” is made from a mixed family.

In the families that remain, certain typical healthy plants are picked out and labelled for selfing. Selfing is performed by boys, using small bags of mosquito netting (4 by $2\frac{1}{4}$ inches) which are pulled over the top of the bud and secured by a piece of soft copper wire. This method, though not nearly so rapid as some others, is preferred as being nearly fool-proof and allowing of rapid supervision.

In picking, a small double bag of calico is attached to each tree on which selfing has been done. “Selfed” bolls are picked, entire, into one side of the bag, whereas cotton from naturally fertilized bolls is placed in the other side.

Cotton from a number of other (unselfed) plants is also picked, in order to enable laboratory records to be made on a family as a whole. The picking is done into small single bags in this case.

Boll-maturation data are collected on the selfed bolls only.

The laboratory examination has had to be kept within strict

limits owing to the lack of any trained reliable staff accustomed to this work.

The following points have been dealt with during the past season:

Yield of seed-cotton.	
" " seed (natural and self-bred).	
Halo length.	
Lint index.	
Ginning out-turn (percentage).	
Weight of 100 seeds.	
Colour	} Hand and eye judgments.
Fineness	
"Toughness"	
Lustre	

Any plants which, judged on their family record, appear to be likely to breed approximately true for the particular character desired will be transferred in the following season to the "Pedigree Line" plot.

Pedigree Line families are sown in small compact blocks, approximately square, and, as a rule, the progenies of several sister plants are sown immediately alongside, for comparative purposes and in order to gain more complete evidence as to purity of type.

The field and laboratory records are similar to those made in the case of "New Selections."

(4) TRIALS OUTSIDE SHAMBAT HALFYA.

Small quantities of seed of various types of cotton have been issued to various places from time to time for trial, but lack of time and staff have hitherto prevented anything in the nature of organized variety trials on a replicated bed system.

The information obtained from these issues has usually been very scanty, and, at the best, cannot be expected to amount to more than a decision as to whether a variety will "do" or will "not do" in a certain locality.

All seed issues for the season under review had naturally been made before my arrival in the country.

The most important issue was one of American varieties to Mikeilab Pump Station in Berber Province. A total of 300 feddans was sown with seven different types:

Webber Strain 32	..	..	..	50 feddans
" " 36	..	..	..	25 "
" " 38	..	..	..	25 "
" " BS	..	..	..	100 "
Columbia " 40	..	..	..	25 "
" " 43	..	..	..	25 "
Selected Gendettu	..	..	..	50 "

All the above resulted from single-plant selections made by Mr. Massey. The Webbers and Columbias were selected in 1922-23 from small plots grown from seed which had been freshly imported from the States. The Gendettu type was selected from the local field-crop type in the same year.

The soil at the Mikeilab Station consists partly of Karu soil (see Introduction), and partly of a light sandy recent alluvium, referred to there as "Gezira" soil. This latter is, however, quite a different type to the æolian soil of the Gezira tract. Part of each variety was sown on each kind of soil.

The quality and strength of the soil varied considerably from place to place, and comparative yield figures are therefore of little value. Webber 32 and 38 gave satisfactory yields both on the light and heavy type of soil, and Columbia No. 40 also appeared satisfactory in both cases. The yields of other types were too irregular to allow of any conclusions being drawn.

Samples of lint of all the above types and of the "standard" Pump Scheme Strain were examined in our laboratory. Columbia No. 43 was easily the best, being long, strong, and fine. It pulled to a length of $1\frac{5}{16}$ inches, and showed a nice even colour, white with rather a creamy tint. Columbia No. 40 was not nearly so satisfactory. The Gendettu selected strain of "Pump Cotton" came next in order of quality, and the best of the Webber strains appeared to be Webber 38.

The strain referred to as "Webber BS" was distinctly lacking in length, strength, and fineness, and, as its yield also appeared to be unsatisfactory, this variety has been cut out altogether.

As regards the remainder, Webber 38 will be tried out in a variety test in the coming year, and I have recommended that a quantity of seed not exceeding 50 ardebs of each kind should be stored pending further tests.

Seed issues, to places other than Mikeilab, were made as detailed on p. 133.

The two lots sent to Singa and Gedaref both proved a failure owing to abnormal drought.

As regards the others, no reports have been received, except from the Seed Farm, Barakat, where Mr. Jefferys made some observations to the effect that the Sea Island types were less attacked by Black-arm in the early stages, but all succumbed later. Three months after sowing, all the varieties, but particularly the Sea Islands, went yellow and dropped their leaves and buds, the cause being unknown.

Yield results are naturally low and have no significance.

<i>Where Sent.</i>	<i>Variety or Strain.</i>	<i>Quantity.</i>	<i>Notes.</i>
Seed Farm, Barakat	Bolland's Sakel 19	25 rotls	Single plots for observation as to behaviour.
	Sea Island A	1½ "	
	" " B	1½ "	
	" " C	1½ "	
	" " D	1½ "	
Experimental Plot, Singa	Gendettu Selected	100 rotls (approx.)	Single plots for observation under control of Inspector, Makwar. Total area under these strains 5½ feddans.
	Lone Star	15 " "	
	Acala	15 " "	
	Durango	15 " "	
	Lightning Express	15 " "	
Experimental Plot, Gedaref	Same series as supplied to Singa	Ditto	Ditto.
Makwar, Abu Geili. .	Dixie (Bulk)	15 sacks	Sown at Abu Geili; believed to be about 200 feddans. (Under Supervision of Inspector of Agriculture.)
Makwar, Abu Geili	Pedigree Dixie	400 rotls (approx.)	On Gerf Land. Native cultivators supervised by Inspector at Makwar.
	Lightning Express	100 " "	
Makwar, Mahmoud Island	Pedigree Dixie	30 rotls (approx.)	Native cultivators supervised by Inspector at Makwar.
	" Webber	100 " "	
	Lightning Express No. 1	130 " "	
Makwar Garden ..	Gendettu Selected	140 rotls (approx.)	Supervised by A/D.C., Makwar. Land rented to native cultivator. About 40 feddans of cotton.
	" Webber	100 " "	
	Lightning Express No. 3	100 " "	
Governor, Blue Nile	Bagged Pedigree Dixie	350 rotls (approx.)	
	Bagged Pedigree Webber	30 " "	
	Lightning Express No. 1	100 " "	
	No. 2	100 " "	
	No. 3	100 " "	
Malakal, Upper Nile	Lightning Express No. 1	10 rotls (approx.)	Supervised by Inspector of Agriculture, Upper Nile. Amounts sent in some cases uncertain, but total appears to have been 3½ ardebs.
	No. 2	10 " "	
	No. 3	10 " "	
	Bagged Pedigree Webber	10 " "	
	Cleveland Big Boll	10 " "	
	Gendettu Selected	(?)	
	Bagged Pedigree Dixie	(?)	

(5) DEVELOPMENTAL OBSERVATIONS ON COTTON PLANTS.

Before it is possible to make records which will be of real value in the comparison of varieties and strains of cotton, it is necessary to obtain clear information as to the effect of situation and climate on the plants with which one is working. A normal Sakel plant of the Egyptian Delta would, except for the shape of its bolls, be unrecognized in this country and *vice versa*.

The cotton plant is much affected by its environment, and a description which would apply in one country might be very far out in another. Furthermore, the whole habit of growth may be altered by sowing at different times of the year.

With this in view a special study, from the developmental point of view, is being made of one Egyptian (Sakel) and one American (Webber) type of cotton.

The plants are being grown in large boxes filled with a uniform mixture of soil. Variable soil conditions are thus eliminated, and the direct effect of climate can be more easily studied.

Similar studies having been made by myself in Egypt, it is hoped that it may be possible to draw useful comparisons.

A new series is being sown each month, and the reaction of the plants to the different climatic conditions which obtain in each case is remarkable. It appears that the suppression of fruiting branches in the lower axils of the stem referred to elsewhere in this report as being typical of Sudan Sakel is directly attributable to the effects of high temperature, though the main growing point of the stem seems to be unaffected.

Both the formation and the shape of the vegetative branches also are equally susceptible to modification from the same causes.

The series so far only extends to one-half of the year, so that a more detailed consideration of results will be postponed until a later report.

APPENDIX A.

RECOMMENDATIONS RE SEED SUPPLY IN THE SUDAN.

The complaints which have been heard during the last two or three years on the matter of deterioration of Egyptian Sakel, and the costly attempts which are now being made by the Egyptian Government to improve the situation, serve to emphasize the extremely favourable position in which the Sudan at present finds itself in this respect.

The "deterioration" complained of in Egyptian Sakel is due to three main causes: (1) The intentional adulteration, before or after ginning, of Sakel cotton with inferior types such as Pelion; (2) the mixing of seed stocks, either intentionally or otherwise, which takes place firstly at the gins and later at all stages in the distribution of seed; and (3) the natural cross-fertilization which occurs in the field when two different varieties are grown side by side.

The only effective remedy lies in complete control by Government of ginneries and of seed production throughout the country.

At present this ideal is practically in existence in the Sudan. All ginneries are worked by the Government either directly or indirectly through the Sudan Plantations Syndicate, with the exception of one at Suakin; and under the terms of the Cotton Ordinance, 1925, the Government has powers to prevent any person sowing cotton seed other than that approved by the Department of Agriculture and Forests.

I should like to record my opinion as to the vital necessity of this control being retained to the full or even further extended.

As competition from other countries less favoured in this respect increases, it may well be that the future of cotton-growing in the Sudan may come to depend upon the establishment of a reputation for purity and evenness of type.

If suitable varieties for the different districts can be found, these should be adhered to, and the number of different types should be as few as possible.

Ginneries should be arranged, where feasible, so that they deal with only one type of cotton, and should in any case be entirely under control of Government, as being the only certain means of preventing the intentional mixing of seed-cotton in the gins, and also of preventing the sale of seed for sowing, which is unfit for the purpose. The ginneries are the key to the whole problem of control and standardization.

Before ginning out special pure seed-lots, it is essential that the gins themselves and all conveyors and other accessory portions should be thoroughly and completely cleaned. To do this effectively means complete stoppage and consequent loss of time and money, which can hardly be borne by private enterprise.

The actual production of seed for sowing the main cotton areas should be carried out only in certain defined and predetermined areas, and seed should not be drawn from the main areas themselves. A sharply defined area of limited extent can be "cleaned" in a comparatively short space of time by "flushing through" each year

with a fresh supply of pure seed from a carefully rogued propagation area.

In this respect also the Sudan possesses certain clear advantages, and the following suggestions are put forward with the idea of using these advantages to the full.

(A) SEED PRODUCTION FOR THE GEZIRA—(i.) *First Stage: Production or Introduction of a New Variety.*—This should invariably be carried out by or through the agency of the Plant Breeding Section, who are in a position to multiply up small stocks of pure seed without risk of cross-fertilization in the early stages.

The Shambat Pump Area, isolated as it is from other cotton areas, is ideal for the purpose, and on it a comparatively large scale field trial (500 feddans) can be carried out without interfering with any existing established variety in the Gezira.

It does not necessarily follow that what suits Shambat will also be suitable for the Gezira, *but carefully conducted variety tests carried out in triplicate at Shambat and at two stations in the Gezira* will enable the necessary judgment to be made as to whether the results obtained on a large scale at Shambat are applicable or not.

As soon as it has been decided to adopt a new variety, sufficient seed will be obtainable from a carefully rogued area in the middle of the Shambat pump land to sow the "roguing plot" which, it is recommended, should be permanently established in the existing seed farm area at Barakat.

From that point onwards, the suggested method of increase will be identical with that to be followed in the case of a previously established variety, as explained below:

(ii.) *Second Stage: Maintenance of Supply of Pure, Healthy Seed in Case of an Established Variety.*—The proposed scheme is shown graphically in Diagram A.

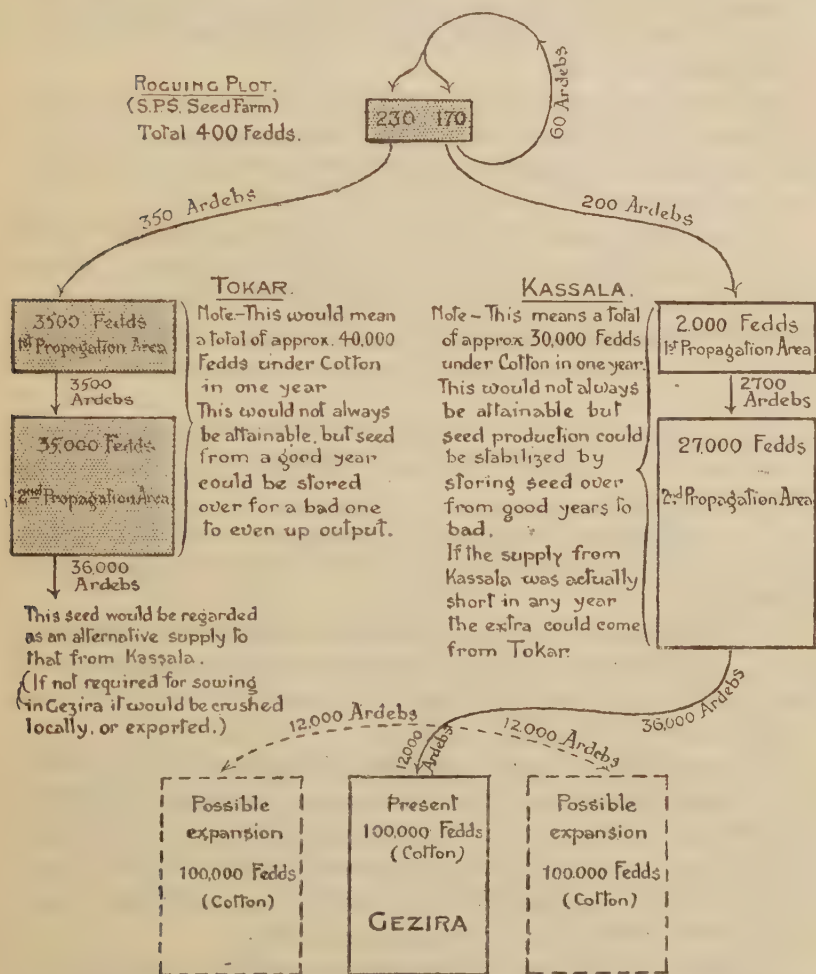
The two areas, Kassala and Tokar, are brought into the scheme owing to the invigorating effect which a season's growth at these places appears to have on the resulting seed.

From this point of view Tokar would seem to have an advantage, especially as Black-arm is apparently unknown there, but certain administrative difficulties at present point to the use of Kassala as the main channel of seed supply. The suggestion is that the Tokar area should always be kept supplied with identically the same seed as that which goes to Kassala, so that it can always be fallen back upon as a reserve, without alteration of the type of the seed to be sown in Gezira.

It is suggested that both Kassala and Tokar should be fed with

DIAGRAM A

DIAGRAM ILLUSTRATING SCHEME OF SEED PRODUCTION FOR THE
GEZIRA USING KASSALA AS THE MAIN CHANNEL OF SUPPLY WITH TOKAR
AS AN ALTERNATIVE



NOTE:—The seed rate and estimated seed production vary at different stages.
A very liberal seed rate has been allowed in the early stages.

Seed Rates	Early stages ..	1 ardeb to	6-7 feddans (approx.)
	Tokar ..	1	10 " "
	Kassala ..	1	10 " "
	Gezira main crop	1	8 " "
Yield of Seed	Early stages ..	1 feddan	→ 1½-2 ardebs
	Tokar ..	1	→ 1 ardeb
	Kassala ..	1	→ 1½ ardebs

seed grown on a roguing area of 400 feddans situated on the Sudan Plantations Syndicate's Seed Farm at Barakat.

The area is very large for thorough roguing, but it would have to be gone through as thoroughly as time and staff permitted. A small portion of the area would be ear-marked for supplying seed for the roguing plot itself in the following year. This portion would be rogued very carefully indeed, and should be big enough to supply about 60 ardebs of seed.

(B) SEED PRODUCTION FOR RAIN-COTTON AREA—(i.) *First Stage: Production or Introduction of a New Variety.*—As in the previous case, this should be carried out by the Plant Breeding Section, and for the same reason.

A small plot of about $\frac{1}{2}$ feddan, situated in the immediate vicinity of the Shambat Experimental Farm, would be sufficient to supply the seed for sowing the proposed roguing plot at Mikeilab [see (ii.) below]. When the roguing plot stage had been reached, propagation should proceed exactly as in the case of a previously established variety.

The $\frac{1}{2}$ feddan at Shambat would itself be supplied with self-bred seed (about 15 rotls would be required) direct from the breeding plot at Shambat.

(ii.) *Second Stage: Maintenance of Supply of Pure, Healthy Seed in Case of an Established Variety.*—The essential points of this scheme are:

1. That all seed of rain areas should be supplied only from crops grown on the Government pumping stations, supplemented, if necessary, by seed from sagia land in the same districts (Berber and Dongola), and possibly later by Zeidab.

It is much to be hoped that the Zeidab estate, which is owned and administered by the Sudan Plantations Syndicate, will fall in with the general scheme, but failing that, it should readily be possible to obtain sufficient seed for sowing some 250,000 feddans of rain-cotton, without tapping Zeidab and without having to make use of rain areas for the production of seed for sowing.

2. That the interests of the pumping stations should be subordinated, *if it be found necessary*, to the interests of the rain area as regards the actual variety of cotton grown.

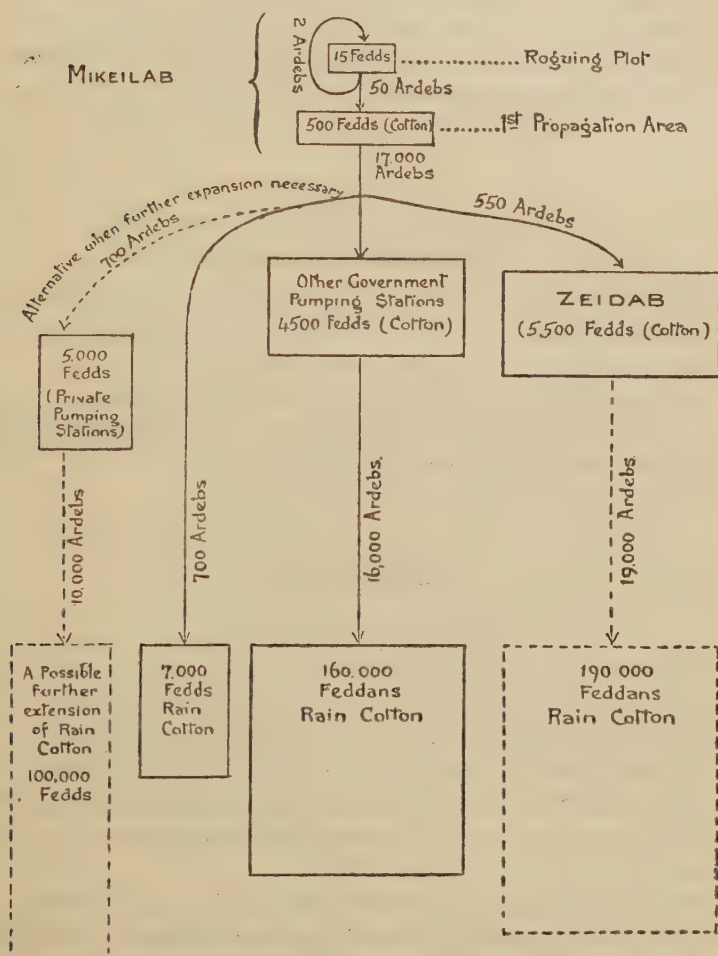
This point would very likely not arise at all, and if it ever did, the loss to the pumping stations would be relatively very slight.

3. That one of the pumping scheme areas should be definitely set aside as a special area, wherein would be sited both a roguing plot (15 feddans) and a propagation area (500 feddans).

DIAGRAM B

AMERICAN COTTON

DIAGRAM SHOWING SUGGESTED SCHEME FOR SEED SUPPLY OF AMERICAN COTTON FOR RAIN AREAS



NOTE:

Seed Rates	{ Irrigated land	1 ardeb (144 rotls) to	7-10 feddans
	{ Rain land ..	1 " " " "	10 "
Yield of Seed	{ Pump land ..	roughly 3½ ardebs per feddan	
	{ Sagia land	about 2 ardebs	"

In view of the importance of keeping this "seed-bed" clean, it is recommended that the same station should be used year after year, unless very strong reasons to the contrary should arise.

In this connection an attack of Pink Bollworm should not be considered sufficient reason for changing this primary area, unless of such severity as seriously to jeopardize the possibilities of procuring a sufficient bulk of seed.

The locality selected should be conveniently situated as regards Khartoum, and trained assistance in roguing could then be provided from Shambat. Mikeilab would appear to be suitable for the purpose.

The scheme of propagation suggested is illustrated in Diagram B.

APPENDIX B.

THE TESTING OF VARIETIES.

The elaboration of a scheme for the testing of varieties under critical conditions and over a wide range of country has been one of the most important tasks of the present season.

It is hoped that a start will be made with this scheme in the coming year. Details of the scheme, as well as of individual results obtained, will be published in a subsequent report.

APPENDIX C.

MEETINGS ATTENDED.

On December 11, 1925, I attended a meeting of officials of the Sudan Government and of the Sudan Plantation Syndicate, which took place at Wad Medani, in order to discuss certain soil problems of the Gezira area, in so far as they affect the growing of cotton.

At the request of Dr. A. F. Joseph, I contributed a paper entitled "A Preliminary Note on the Development of the Cotton Plant in the Gezira."

This paper, along with others read at the same meeting, has been published by the Wellcome Tropical Research Laboratories, Khartoum, under the title of a "Report of Meeting in the Sudan Gezira, in December, 1925, for the Discussion of certain Problems connected with Cotton-Growing."

[Reprinted by courtesy of the Uganda Government.]

UGANDA

REPORT ON COTTON EXPERIMENTS, SERERE STATION, SEASON 1925-1926

BY
G. W. NYE.

THE writer took over the work of cotton-breeding at Serere Experiment Station in October, 1924. For previous work carried out at Serere reference should be made to the Annual Reports of Uganda Agricultural Department and to an article by Mr. Harper, Senior Agricultural Officer, in the *EMPIRE COTTON GROWING REVIEW*, Vol. III., No. I.

Before a general account of the year's work is given a few words may be written on the present condition of cotton in Uganda.

The type of cotton chiefly grown in Uganda at the present time is of the Nyasaland Upland type, though in parts of Buganda Province "Sunflower" is still grown.

The Nyasaland variety is characterized by an erect, bushy habit of growth, rather inclined to get straggly and "lodge" if the rainfall is high during the early period of growth. It has a high bud and boll shedding percentage, though evidence exists that slightly resistant strains are present. The lint length varies from under an inch to $1\frac{5}{8}$ inches, the lint being of excellent quality and strong, though these characters are somewhat variable. The yield of this variety is largely dependent on climatic and soil conditions, but as mentioned above shedding resistant strains do exist, and one of the objects of the work at Serere is to select them out.

As is seen in the table below, the yield per acre is low, though in Teso county there are Gombololas such as Labori where well over 1,000 lbs. of seed cotton are obtained per acre.

TABLE I.
Yield per Acre.

<i>District.</i>	<i>Yield per Acre.</i>	
	1924.	1925.
Teso	358 lbs.	274 lbs.
Lango	412 "	302 "
Busoga	572 "	485 "
Bugwere	319 "	423 "
Bugishu	211 "	141 "
Budama	249 "	169 "

} Seed cotton per acre.

These figures are worked out from the acreage and buying figures given in the Monthly Cotton Reports issued by the Department of

Agriculture. They are only rough calculations, but the yield is certainly not higher than these figures.

Undoubtedly there is plenty of scope for improvement, and apart from selection work of breeding out higher yielding strains, there is much to be done in general improvement of cultivation, especially in such operations as proper stumping of plots and filling up gaps left by poor germination, both of which cause a considerable reduction in the possible yield if not attended to.

The general practice in Eastern Province is to sow from mid-May to mid-August, though May is now recognized as being too early, and very little sowing is done then. The cotton is sown in rows 4 feet apart with 2 feet between each hole, and it is the rule that only one plant should be left per hole. All cultivation is done on the flat. These facts at once show need for plot experiments, and as will be seen below a number of these have been started in order to ascertain the optimum spacing, sowing date, and so forth.

MAIN OBJECTS OF WORK AT SERERE.

It is as well to state a few of the chief objects of the cotton research work now being carried out at Serere. First and foremost is the production of a pure strain of cotton regular in strength and staple, the latter to be fully $1\frac{3}{16}$ inches (30 mm.). At present no pure strain is existent in Uganda and, as a consequence, the crop is generally mixed and rather irregular.

Secondly comes the question of improvement in yield, which is being tackled both by selection and by field experiments on methods of cultivation.

Thirdly, there is the selecting out of strains improved in quality, and also the testing of new varieties with the ultimate object of having a reserve of tested new types in the event of the present seed becoming liable to disease attacks, or of another type of cotton being desired by spinners.

SELECTION WORK.

On the writer's arrival at Serere a number of different varieties of American Upland were being grown in small plots, and also a number of progeny rows from Nyasaland and Sunflower single plant selections made by Mr. Harper during the previous season.

It was decided to start the selection and breeding work quite afresh, and for a start a field examination was made of all types of cotton grown at Serere; these were as follows: Nyasaland, Sunflower, Allen, Salisbury, Meade, Acala, Durango, Colombia, Kasch, Delfos, Webber Delta Type, Webber Long-Stapled Upland, Assili, and Sakel.

As a result of the examination held in the field and in the office a number were definitely discarded as being too short in staple and of very poor quality lint; these were Kasch, Delfos, Colombia, and Webber Delta Type.

Individual plants were selected amongst the others, primary selection being for a sympodial branching habit. All plants were self-fertilized by tying the tip of the flower-bud with fine twine. The best time to do this was early in the morning between 6 a.m. and 8.30 a.m., as no flowers were observed to open before 8.45 a.m. Native pupils did the tying work, and, although rather clumsy, they became quite adept at the work.

Boll-shedding counts were made weekly and bolls picked separately from each plant and examined. The following characters were recorded for each healthy boll: loculus number, seeds per loculus, weight of seed cotton per boll, weight of lint per boll and lint length. Means of these were worked out for each plant, and also mean ginning outturn and lint index.

Selection was done on these individual plants, the following characters being looked for: long staple, large number of seeds per boll, high weight of lint per boll, high lint index, and a high ginning outturn when combined with a high lint index.

The following table gives a summary of these characters in those plants which were selected for growing in progeny rows, 1925-26:

TABLE II.

<i>Strain.</i>	<i>Bolls Pro- duced.</i>	<i>Loculus Number.</i>	<i>Seeds per Boll.</i>	<i>Lint Weight per Boll in Grms.</i>	<i>Seed Weight per Boll in Grms.</i>	<i>Lint Index.</i>	<i>Ginning Outturn.</i>	<i>Lint Length in Mm.</i>
SG 1 (Nyasa No. 12)	34	4.3	29.7	1.08	3.33	3.64	24.5	33.6
SG 2 (Nyasa No. 12)	15	4.0	27.6	1.37	2.53	4.95	35.2	30.2
SG 3 (Salisbury)	34	4.25	37.4	2.38	5.00	6.35	32.2	29.6
SG 5 (Salisbury)	20	4.4	37.4	2.58	4.00	6.9	39.2	28.7
SG 11 (Salisbury)	31	4.01	38.1	2.03	4.3	5.36	31.7	27.6
SG 15 (Nyasa No. 25)	34	4.3	29.2	1.85	4.92	6.32	27.6	34.9
SG 19 (Salisbury)	18	4.4	39.9	2.66	4.88	6.42	35.3	30.3
SG 20 (Nyasa) ..	—	4.0	31.7	1.75	3.73	5.5	32.0	32.0
SG 21 (Nyasa) ..	—	3.5	—	1.14	2.91	—	28.2	33.2
KG 2 (Nyasa No. 32)	—	—	—	—	—	4.75	31.8	30.6
LG 3 (Nyasa No. 17)	—	—	—	—	—	4.00	28.5	30.2
LG 4 (Nyasa No. 32)	—	—	—	—	—	3.05	32.5	29.1

A summary of a broker's report on lint from some of the above strains is given below:

- SG 1.—Good, medium strength, silky, staple $1\frac{3}{8}$ inches.
- SG 2.—Strong, regular, good feel; $1\frac{3}{8}$ " staple.
- SG 3.—Good $1\frac{1}{8}$ " staple, medium strength, very little harsh
- SG 5.—Below medium strength, irregular, $1\frac{1}{8}$ ".
- SG 11.—Medium strength, fairly regular.
- SG 15.—Strong, good feel, regular; staple full $1\frac{3}{8}$ ".
- SG 19.—Fairly strong, good feel.

Each selection is given a serial number to avoid mistakes and bias on the part of the observer. The first letter indicates the place of origin—*e.g.*, S = Serere, L = Labori, T = Trinidad.

It was well recognized that haphazard selection of individual plants was a risky procedure, but a start had to be made somewhere, and the first selections were looked upon as providing cultures from which individual selections could be made with more certainty, as their ancestry would then be known and their subsequent behaviour be more or less foretold before they matured.

Besides these progeny rows which were sown 1925-26, several selections were made in native plots and also rows were grown from mixed seed of other Nyasaland Strains, Allen, and certain varieties brought from Trinidad by the writer.

These progeny rows were sown at Serere on June 30, 1925, in rows 4 feet apart and 2 feet between each plant. Each row consisted of fifteen plants only, as any greater number would make the collection of such data as were needed an impossible process.

Weekly growth records were taken from two plants in each row, and daily flowering counts were made on every plant. Every flower was self-fertilized by the method mentioned above. Bolls were at first picked twice a week, but later it was found impossible to deal with all the material, and space was so limited that picking was done once a week only. Each boll was picked separately, and the same data recorded as for the individual selection in the previous year.

The analysis of all data collected from these rows and the working out of flowering and bolling curves is proceeding at the present time, and the results will be presented in the report for next year.

Certain of the progeny rows have been selected for growing in increase plots, 1926-27, and a summary of the main character of these rows is given in Table III.

The strains mentioned in the table have either been selected for growing in increase plots or they are those from which individual plants have been selected for growing in progeny rows, 1926-27.

TABLE III.

Strain.	Germina- tion. (per Cent.).	Total Flowers per Plant.	Total Bolls per Plant.	Mean Percentage Bolls Shed.	Mean Number of Days to First Flower.	Mean Number of Days from Flower to Boll.	Loculus Number.	Seeds per Boll.	Lint Weight per Boll in Grms.	Seed Weight per Boll in Grms.	Ginning Outturn.	Lint Index.	Lint Length in Mm.
SG 1 ..	7	132.8	31.1	77	87.2	59.4	4.12	30.02	1.28	3.37	27.6	4.21	31.27
SG 2 ..	40	117	38.9	67	80.5	59.5	4.17	33.20	1.54	3.46	30.8	4.65	29.40
SG 3 ..	87	116	31.0	73.4	79.3	59.3	—	—	—	—	—	—	—
SG 13 ..	100	75.7	21.8	71.3	78.0	60.4	4.20	31.9	1.63	3.79	30.2	5.11	29.7
SG 15 ..	52	84	24.1	71.5	86.0	61.0	4.15	31.07	1.47	3.69	28.2	4.87	31.9
SG 20 ..	73	90	31.9	65.0	83.0	59.9	4.1	31.8	1.58	3.25	32.8	4.98	29.4
SG 21 ..	94	93	31.2	66.3	81.0	59.3	4.04	32.1	1.42	3.29	30.0	4.55	29.01
SG 26 ..	87	135	37.4	72.6	85.0	59.3	—	31.1	1.49	3.57	29.4	4.80	29.9
SG 27 ..	80	119	34.5	71.0	85.5	60.4	—	30.9	1.58	3.74	29.8	5.12	29.7
SG 29 ..	—	148	39.1	74.0	82.1	65	—	31.8	1.76	3.86	31.3	5.64	30.2
SG 37 ..	80	124	39.0	68.5	82.7	63.6	4.11	32.3	1.44	3.41	29.7	4.45	29.8
LG 4 ..	93	71.5	21.5	69.7	93	61.9	—	33.2	1.68	3.58	31.9	5.05	28.8
TG 5 ..	100	61.6	16.7	72.5	—	61	4.21	38.6	—	—	—	—	26.0

The following are those strains selected for increase plots:

SG 15.—A selection from Nyasaland. This strain has a long staple and is excellent in quality, and it has been selected on these characters alone.

SG 26.—Also a Nyasaland selection. There is no outstanding character in this strain, but as a whole it is quite promising.

SG 27.—A Nyasaland strain with high lint index and a fair staple.

SG 29.—A high yielding Nyasaland strain with a high lint index combined with a high ginning outturn. The staple is full $1\frac{3}{16}$.

SG 37.—A selection from Allen variety, selected chiefly on account of the favourable reports from England which this variety has always had.

These five strains will be grown in $\frac{1}{4}$ -acre plots and will be thoroughly examined both in the field and in the laboratory.

It will be noticed in Table III. that the shedding of bolls is very high indeed; while this is chiefly due to climatic conditions, no doubt some is due to mechanical injury to the flower-buds when they are tied up for selfing purposes. In order to ascertain how much shedding is due to this cause, control plants will be grown in each row in 1926-27, on which no flowers will be selfed, but flower and boll counts made. No cotton will be retained from these controls as cross pollination will occur.

As mentioned above, a number of single plants were selected for growing in rows next year. A summary of their more important characters is given in Table IV.

Here, again, the selected plants may be extremes of normal variation, but this can only be ascertained from next season's results.

All these selections have a long staple with the exception of SG 3-2, which is from Salisbury variety and has been selected on account of high loculus number and large number of seeds per boll. LG 4-15 is rather short-stapled, but it has a very high ginning percentage combined with high lint index.

The other plants are the most promising of their row, and should show less variation next season.

Lint from all the selected rows and from some of the individual plants has been sent to England for report by brokers, but their reply has not yet been received.

TABLE IV.

<i>Plant.</i>	<i>Total Flowers.</i>	<i>Number of Days from Flower to Boll.</i>	<i>Total Bolls.</i>	<i>Percent- age of Boll Shedding.</i>	<i>Lint Length (Mm.).</i>	<i>Ginning Outturn.</i>	<i>Lint Index.</i>	<i>Locusus Number.</i>	<i>Number of Seeds per Boll.</i>	<i>Seed Weight per Boll (Grms.).</i>	<i>Lint Weight per Boll (Grms.).</i>
SG 2-10	130	58	60	54	31.1	31.3	4.96	4.08	31.6	3.45	1.57
SG 3-2	238	59	63	73.5	25.6	—	—	4.4	35.0	—	—
SG 13-11	115	62	38	64	29.6	30.8	4.62	4.30	34.8	3.62	1.61
SG 13-13	94	—	32	66	30.7	30.8	6.00	4.09	32.3	4.34	1.93
SG 15-7	118	—	36	69.5	33.7	28.6	4.99	4.40	30.4	3.82	1.53
SG 15-13	46	—	14	69.6	34.2	30.2	5.35	4.13	30.1	3.66	1.61
SG 15-14	103	—	44	57	31.7	28.8	4.40	4.15	32.4	3.53	1.43
SG 20-2	111	59	44	58.5	30.4	35	5.30	4.10	33.7	3.27	1.79
SG 20-6	127	52	60	52.5	29.8	34.1	5.00	4.01	30.5	2.94	1.53
SG 20-12	88	—	28	68	29.0	35.8	5.35	4.10	33.7	3.24	1.80
SG 26-2	114	62	35	69	31.0	28.0	4.25	4.01	33.4	3.66	1.42
SG 26-12	153	—	44	71	30.8	27.7	5.05	4.01	31.8	4.20	1.61
SG 26-13	127	63	46	64	30.5	31.4	5.25	4.01	30.8	3.52	1.61
SG 27-7	174	—	51	71	30.3	30.01	5.35	4.00	29.8	3.68	1.59
SG 27-11	188	62	64	66	29.4	29.8	4.99	4.01	32.5	3.81	1.62
SG 27-15	127	—	35	72	30.5	30.0	5.56	4.11	37.2	4.89	2.04
SG 29-1	334	—	100	67	32.1	31.4	5.56	4.06	32.7	3.97	1.82
SG 29-2	152	—	53	65	30.6	32.5	6.35	4.10	30.1	3.97	1.92
SG 29-9	186	—	46	75	30.4	32.6	6.01	4.27	33.1	4.16	2.00
SG 37-6	164	—	43	74	30.05	25.7	4.60	4.20	33.9	4.49	1.56
SG 37-13	130	—	40	69	29.6	32.9	5.25	4.00	31.7	3.56	1.73
LG 4-15	91	—	26	71	28.3	35.2	6.15	4.01	36.0	4.08	2.22

OTHER PROGENY ROWS.

Besides the progeny rows for selection purposes, a number of different species of *Gossypium* were grown to find out their general behaviour under climatic conditions different from their own habitat. Similar records to those mentioned above were kept for each row.

1. *Sea Island* (TG 2):

This was seed from Trinidad, grown there 1923-24. Growth was fairly rapid, and rather straggling plants resulted. Flowering was prolific, but the rate of boll-shedding was very high and only two plants gave any yield at all. All plants suffered from Black Arm and Angular Leaf Spot.

SUMMARY OF TEN PLANTS.

Total Flowers.	Number of Days from Flower to Boll.	Total Bolls.	Percentage of Bolls Shed.	Lint Length (Mms.).	Ginning Outturn.	Lint Index.	Loculus No.	Seeds per Boll (Grms.).	Lint Weight per Boll (Grms.).	Seed Weight per Boll (Grms.).
Mean 76.4	65	19.7	74.5	34.7	25.0	4.05	3.7	23.8	0.97	2.90

It will be noticed that the lint length is somewhat shorter than normal *Sea Island*, and the quality of the lint was not so good as that from the West Indies.

2. *Cauto* (TG 1):

A perennial cotton from Trinidad. The rate of growth was extremely slow, and at the end of April only one plant was higher than 2 feet 8 inches.

Although the plants have been left, no further growth has been made up to the time of writing (June).

Very few flowers were produced, and still fewer bolls. All plants suffered from Black Arm.

An analysis of total flowers and bolls produced is appended below:

Plants.	Flowers.	Bolls.	Shedding (per Cent.).
1	65	31	47.7
2	5	—	100
3	4	—	100
4	10	2	80
5	5	1	80
6	8	2	75
7	10	1	90
8	7	—	100
9	4	—	100
10	6	—	100
Total ..	124	37	70

Plant No. 1:

Loculus number	..	..	..	..	3.00
Seeds per boll	..	..	..	..	22.20
Lint per boll (grms.)	..	..	..	..	1.39
Seed per boll (grms.)	..	..	..	..	2.87
Ginning outturn	..	..	..	..	32.6
Lint index	..	..	..	..	5.95
Lint length (mms.)	..	..	..	..	32.4

3. *Pima* (TG 4):

Egyptian Cotton from Arizona grown in Trinidad. This grew very rapidly, but suffered very badly from *Bacterium Malvacearum*, and, as a consequence, bud and boll shedding was high.

Very few of the bolls picked were diseased.

4. *Lonestar* (TG 5):

An Upland type obtained from Trinidad. Plants were short, bushy, and early maturing, but boll-shedding was exceptionally high.

It has very large bolls with a large proportion of five-locked ones. Lint short and rather harsh.

Altogether forty-five progeny rows were grown, and over 14,000 bolls were examined in the laboratory. Unfortunately time has not permitted for a full analysis of these results to be presented in this report, and little value would be obtained from only one year's results. It is hoped at the end of three years that with the considerable data which will have accumulated a full analysis will be able to be made and conclusions of value arrived at.

CROSSES.

Several crosses were made by the writer when at the Imperial College of Tropical Agriculture, Trinidad, in 1923-24, the F1 generations of which were grown at Serere in 1925-26. All showed remarkable hybrid vigour; F2 generations will be grown in the coming season. A cross made at Serere between Salisbury and Nyasaland varieties was grown as an F1 1925-26.

The crosses are as follows:

TG X1	..	..	..	Cauto × Sea Island.
TG X2	..	..	..	Meade × Sea Island.
TG X3	..	..	..	Sea Island × Lonestar.
TG X4	..	..	..	Sea Island × Acala.
TG X5	..	..	..	Lonestar × Pima.
TG X6	..	..	..	Acala × Pima.
TG X7	..	..	..	Lonestar × Acala.
TG X8	..	..	..	Meade × Acala.

SELECTIONS OF 1924-25.

In 1924-25 a number of progeny rows from single plant selections made by Mr. Harper in the previous year were growing at Serere;

examination was made of all Nyasaland rows for the purpose of selecting a few for growing in $\frac{1}{4}$ -acre plots to build up a supply of improved seed as a stop-gap between No. 17 and the production of a pure line. All these rows were adjacent to one another and had not been selfed, so that considerable intermixing had probably taken place due to cross pollination.

Six of these rows were selected, a summary of their chief characters being given in Table V. below.

TABLE V.

Row.	Weight, 100 Seeds.	Lint Index.	Ginning Outturn.	Lint Length (Mm.).	Strength.	Brokers' Remarks.
N 5	11.55	5.15	30.56	30.51	Medium	Irregular staple.
N 6	12.08	4.97	29.25	30.34	"	Good strength.
N 10	11.58	4.79	29.26	30.08	"	Medium strength.
N 11	12.58	5.37	30.18	30.98	"	—
N 13	11.96	4.99	29.60	31.37	—	Fair strength, generally full, 1 $\frac{1}{8}$.
N 14	12.57	5.58	30.64	30.17	—	Irregular staple.
N 15	12.34	5.17	29.48	30.83	Strong	Good strength, shade harsh.

In 1925-26, when these were grown in $\frac{1}{4}$ -acre plots, it was not possible to make an examination of bolls from them, but the seed cotton was examined in the laboratory, and one plot—N 6—was selected for growing in a 6-acre block in 1926-27 on account of its good quality and of its being the only strain which had retained a staple of 30 mm. A 10-lb. sample has been sent to England for a spinning test.

TABLE VI.

RESULT OF EXAMINATION OF QUARTER-ACRE PLOTS (1925-26) FROM PROGENY
Rows (1924-25). (Cf. TABLE V.)

Plot.	Total Yield, $\frac{1}{4}$ -Acre (Lbs.).	Weight, 100 Seeds (Grms.).	Lint Index.	Ginning Outturn.	Lint Length (Mms.).	Remarks.
N 5	268	12.05	5.12	29.9	27.74	Medium strength, irregular.
N 6	278	11.28	4.53	28.6	30.94	Strong.
N 10	266	11.40	5.00	30.2	29.78	Strong, slightly harsh.
N 11	297	10.62	4.68	30.0	29.06	Strong, harsh.
N 13	242	11.70	5.14	30.4	29.28	Strong.
N 14	254	11.62	5.01	30.0	29.48	Strong, silky.
N 15	311	12.43	5.73	31.6	28.57	—

In selecting these plots, no account was taken of the yield, only one plot having been grown of each strain.

It will be seen in comparing Tables V. and VI. that in nearly every case the seed weight has dropped, and the staple is shorter—probably due to climatic and soil conditions.

RESULTS OF EXAMINATION OF QUARTER-ACRE PLOTS GROWING
IN 1924-25.

A number of these plots were growing on the writer's arrival, and after examination in the field the majority were discarded on account of poor habit of growth and short lint. Three plots were retained and 100 bolls were picked per plot, each boll from a separate plant. These were examined in the laboratory, and finally N 19 and N 24 were selected for growing in 4-acre blocks, 1925-26: N 19 on account of its good quality, high lint index, and long staple, N. 24 chiefly on account of its high yielding capacity as seen from its previous record; but the seed was very mixed, 50 per cent. being green fuzzed and the quality poor. There is no intention of proceeding with this strain on account of its impurity and of the fact that in the yield test it showed no superiority over No. 17; the spinners' and brokers' reports also have proved very unfavourable.

Table VII. shows the results of boll examination of Nos. 19 and 24 and A 2.

TABLE VII.

<i>Strain.</i>	<i>Loculus Number.</i>	<i>Seeds per Boll.</i>	<i>Lint per Boll (Grms.).</i>	<i>Seed Weight per Boll (Grms.).</i>	<i>Lint Index.</i>	<i>Ginning Outturn.</i>	<i>Lint Length (Mms.).</i>
N 19	4-06	33-25	2-06	4-29	6-2	32-5	30-75
N 24	4-30	35-6	1-98	4-03	5-55	33-0	30-54
A 2	4-12	34-1	1-81	3-65	5-4	33-1	27-58

It will be noticed that no Sunflower or Allen strains have been selected for progeny rows or $\frac{1}{4}$ -acre plots; this is because, under present conditions, it is deemed inadvisable to grow several distinct strains in bulk at the same time owing to danger of mixing by intercrossing and mixing of seed. Nyasaland is at present the most suitable variety, but selected strains of Allen and Sunflower are being grown year after year so that if necessary a nucleus for building up a seed supply is available.

FIELD EXPERIMENTS, 1925-26.

Records are available for one year only, and this being so no attempt has been made for the purposes of this report to analyze the results of any experiments or to draw any conclusions as they would be valueless. In a country like Uganda, where the climate varies tremendously from year to year, field experiments will have to be carried out over a period of at least five years before it will be possible to draw conclusions which can be of practical value, therefore the results of this year have been set down as they stand with no attempt to discuss them.

The need for certain field experiments has been stated above (p. 142), and the following classes were begun, 1925-26: Spacing, Sowing Date, Test of Strains.

SPACING EXPERIMENTS.

These were laid down to test various closer spacings against the 4 by 2 feet generally employed by the natives.

The spacings tried at Serere were as follows:

- 4 feet by 2 feet.
- 4 feet by 1 foot 6 inches.
- 3 feet 6 inches by 2 feet.
- 3 feet 6 inches by 1 foot 6 inches.
- 3 feet by 1 foot 6 inches.

Five plots of each spacing were sown in $\frac{1}{25}$ -acre plots.

All plots were sown on July 6 and gaps refilled on July 27.

The following figures give the total yields of seed cotton per plot:

TABLE VIII.

<i>Plot Spacings.</i>	<i>4 by 2 ft.</i>	<i>4 by 1½ ft.</i>	<i>3½ by 2 ft.</i>	<i>3½ by 1½ ft.</i>	<i>3 by 1½ ft.</i>
Pounds of seed cotton per plot	40	35	43	42	39
	38	37	35	31	42
	43	33	39	32	31
	35	29	35	31	26
	36	30	30	38	33
Total yield per spacing (5 plots)	192	164	182	174	171
Mean yield per plot	38.4	32.8	36.4	34.8	34.2
Calculated yield per acre ..	960	820	910	870	855
Reduced to 100	100	86	95	91	90

There is seen to be little difference between any of the spacings except of 4 by 1½ feet, which gives a considerably lower yield than 4 by 2 feet.

Soroti.—A set of spacing plots was laid down in Soroti Station with the main purpose of acting as a demonstration to native chiefs. Owing to labour difficulties only three plots were sown at each spacing, each plot being $\frac{1}{12}$ acre in area. The spacings tried were:

4 feet by 2 feet	1 plant per hole
4 feet by 2 feet	2 plants ..
3 feet 6 inches by 1 foot 6 inches	1 plant ..
3 feet 6 inches by 1 foot 6 inches	2 plants ..

The yields from these plots were as follows:

TABLE IX.—SPACINGS.

	4 by 2 feet (1 per hole).			4 by 2 feet (2 per hole).			3½ by 1½ feet (1 per hole).			3½ by 1½ feet (2 per hole).		
	Good Cotton.	Bad Cotton.	Total.	Good Cotton.	Bad Cotton.	Total.	Good Cotton.	Bad Cotton.	Total.	Good Cotton.	Bad Cotton.	Total.
Yields per plot in lbs. {	18	9	27	23	9	32	23	14	37	20	12	32
	28	14	42	26	11	37	20	11	31	21	11	32
	22	10	32	19	8	27	22	10	32	27	12	30
Totals, lbs.	68	33	101	68	28	96	65	35	100	68	35	103
Mean, lbs.	22·7	11	33·7	22·7	9·3	32	21·7	11·7	33·3	22·7	11·7	34·4
Reduced to 100	100			95			99			102		

All plots are practically identical in their yield, probably due to soil effect, as the plot had been under grass for many years previously and has never had a crop taken off it.

Kyere.—An acre plot was marked out into six $\frac{1}{6}$ -acre plots and two spacings were tried—4 by 2 feet and 3 by 1 foot 6 inches. The experiment was entirely in the hands of the local Chief, and while the results cannot be of value owing to possible inaccuracies, yet every credit should be given to the Chief, who took very great care of the plots and who carried out the trial in a very intelligent manner.

Results:

TABLE X.

	4 by 2 feet.	3 by 1½ feet.
Yields per plot in pounds .. {	90	96
	127	117
	92	110
Total	309	323
Calculated yield per acre ..	618	646

Lira.—A set of similar spacings were tried at Ngetta Plantation, Lira, and carried out by the Agricultural Officer.

TABLE XI.

	4 by 2 feet.	3½ by 1½ feet.	3 by 1½ feet.
Plot yields ..	59 43 44 —	55 65 50 57	58 67 51 —
Mean yield per plot ..	48.7	56.7	58.7
Calculated per acre ..	584.4	680.4	704.4
Reduced to 100	100	117	121

Of all the spacing tests carried out during 1925-26, this one at Lira has given indications of a significant increase due to close spacing. It will be of great interest to see if this is maintained in the coming season.

TWO PLANTS PER HOLE AS AGAINST ONE.

The practice of leaving two plants per hole as against one has been proved to give a higher yield in Egypt, West Indies, and elsewhere. At present only one is left per hole in Uganda, so experiments were started to find out if this be the better practice.

As will be seen in the table of results below, no striking differences in yield were apparent.

Serere.—Six $\frac{1}{6}$ -acre plots. Spacing, 4 by 2 feet.

	1 per hole.	2 per hole.
Plot yields	123 105 118 —	122 107 104 —
Total	346	333
Per acre	692	666

Simsa.—Eight $\frac{1}{8}$ -acre plots. Spacing, 3½ by 1½ feet.

	1 per hole.	2 per hole.
Total yields	111	123
Per acre	222	246

Lira.—Six $\frac{1}{12}$ -acre plots. Spacing, $3\frac{1}{2}$ by $1\frac{1}{2}$ feet.

TABLE XII.

	2 per hole.			1 per hole.		
	<i>Good Cotton.</i>	<i>Bad Cotton.</i>	<i>Total.</i>	<i>Good Cotton.</i>	<i>Bad Cotton.</i>	<i>Total.</i>
	37	21	58	37	16	53
	50	18	68	43	21	64
	43	11	54	38	18	56
	130	50	180	118	55	173
Mean	43.3	16.6	60	37.3	18.3	57.6
Per acre ..	720			692		

SOWING DATE PLOTS.

As will be seen by referring to the introductory remarks of this report, the usual practice in Teso is to sow from May to August, and it is now generally accepted that May is too early. No data exist for Uganda as to the effects of different sowing dates on yield or quality of cotton, so it was decided to lay down a series of sowing date plots. For the first year three dates only were used, in order to save the complication consequent on having a very large number of plots with no proper facilities for dealing with them. These sowings were early June, early July, and early August.

The spacings chosen of each sowing were similar, namely: 3 feet 6 inches by 1 foot 6 inches, and four plots, each $\frac{1}{12}$ -acre, were sown on each date.

In order to ascertain whether a small number of plants gave results comparable to results obtained from the whole plot, and to get data required for other purposes, a row of ten plants was demarcated in the middle of each plot. From these ten plants certain records were taken, such as weekly growth curves, flowering curves, and total yield seed cotton per plant. Originally it had been intended to record weekly boll totals, but this was found to be impossible.

The results of yields per plot are given in Table XIII.

August has, in both cases, given a considerably lower yield, and had not the two June-sown plots been attacked by the Chrysomelid larva the advantage in favour of June sowing would be even greater. The percentage of good to bad follows the same order as the yields, June sowing giving 19.8 per cent. bad; July, 26 per cent.; and August, 27 per cent.

TABLE XIII.

<i>Sowing Date.</i>	<i>Plot Yield in Lbs.</i>	<i>Yield of Ten Plants in Grms.</i>
June 9	86	44.7
	85	66.6
	44*	42.7
	49*	38.8
July 9	78	78.8
	68	33.6
	67	65.3
	41	47.6
August 10	62	46.5
	45	44.1
	47	41.4
	51	48.6

* Both these plots suffered very badly in their young stages from attacks of a root grub—*Syagrus calcaratus*.

TABLE XIV.

<i>Sowing.</i>	<i>Plots.</i>				<i>Ten Plants.</i>	
	<i>Total Yield (Lbs.).</i>	<i>Mean per Plot (Lbs.).</i>	<i>Calculated per Acre (Lbs.).</i>	<i>Reduced to 100.</i>	<i>Mean per Plot (Grms.).</i>	<i>Reduced to 100.</i>
June	264	66	792	100	48.8	100
July	254	62.3	762	96	56.2	115
August	205	51.2	615	78	45.1	80

This experiment is being repeated in 1925-26, in conjunction with the spacing experiment.

TRIAL OF NYASALAND STRAINS.

Before any new strain is grown in bulk, it should undergo a test against the existing type of cotton for yield, especially in the case of strains where little difference exists in quality.

The two strains N 19 and N 24 which were to be grown in 4-acre blocks 1925-26 were tested against N 17, and Table XV. shows the results.

Five plots of each strain were grown in $\frac{1}{15}$ -acre plots on July 16. Spacing was 4 by $1\frac{1}{2}$ feet.

No difference in yield was obtained, but as regards quality No. 24 is, by a long way, the poorest, and it is not a desirable strain to proceed with.

TABLE XV.

	<i>Strains.</i>		
	N 17.	N 19.	N 24.
Yields per plot in lbs. ..	67	60	56
	71	62	76
	73	75	83
	71	68	70
	80	82	75
Total	362	347	360
Mean per plot	72.4	69.4	72.0
Calculated per acre	1,086	1,041	1,080
Reduced to 100	100	96	99

The results of these experiments give indications of differences in yield due to spacing and sowing date. They will be carried on over a period of years, when definite results of practical value will be obtained.

It will be noticed that no remarks have been made as regards disease and pest incidence in connection with these experiments; this is because so much work had to be done in superintending picking of plots and progeny rows, and in analyzing bolls from progeny rows. Natives cannot be trusted sufficiently to be allowed wholly to superintend even plot-picking.

GENERAL LABORATORY WORK.

The cotton laboratory was only completed in January this year, and previous to that space was so limited that no laboratory work could be carried out.

A number of samples of seed cotton and lint have been received from all parts of the Protectorate, and each sample has been reported on. Table XVI. gives a summary of the quantitative characters of samples received.

Altogether eighty samples have been reported on. In future it is hoped that samples will be obtained from each district regularly every year, so that a continuous record of the behaviour of the crop in each district can be obtained, and indications will be found where new seed is necessary. It will be seen from the above table that the quantitative characters are very similar from district to district. Mbale and district and Buganda Province both have a shorter stapled cotton than other districts.

TABLE XVI.

District.	Number of Samples.	Lint Length (Mms.).	Coefficient of Variability of Lint Length.	Seed Weight (100 Seeds)	Lint Index	Ginning Outturn	Seed Purity Percentage
Teso	9	29.7	7.79	10.86	4.72	30.6	88
Lango	9	29.74	7.06	11.15	5.03	30.8	90
Mbale	8	27.94	7.7	11.17	5.00	30.80	Low
Busoga	7	28.54	7.8	10.87	4.60	30.65	"
Buganda Province	8	27.91	8.07	11.03	5.16	31.86	73.4
Northern Province	4	28.5	6.83	10.73	4.75	30.1	87
Masaka	1	30.22	7.2	12.58	6.12	32.8	94
Ukerewe	1	28.00	9.94	9.59	4.34	30.03	82

Lint index is rather low, but the ginning outturn is satisfactory.

The figures for coefficient of variability of lint length show that the staple is rather irregular and there is plenty of room for improvement in this direction.

GERMINATION TESTS.

During the period 1924-26 a number of germination tests have been carried out with various types and strains of cotton.

The method used is placing seeds on moist filter paper in petri dishes, counts of germinated seed being made daily. The petri dish method has one great objection in that the seeds become easily attacked by fungi, and many tests were completely vitiated in this manner.

TABLE XVII.

Strain or Variety.	Year of Tests.	Number of Tests.	Percentage Germination.	Number of Days to Complete Germination.
Nyasaland N 17 {	1925	11	88.3	8.4
	1926	13	50.7	8.4
Nyasaland N 19 {	1925	Nil	—	—
	1926	11	79.6	5.4
Nyasaland N 6 {	1925	Nil	—	—
	1926	3	80.5	6.7
Nyasaland N 24 {	1925	4	83.6	8.2
	1926	Nil	—	—
Salisbury	1925	7	90.7	8.0
Sunflower	1925	3	85.6	4.0
Allen	1925	4	55.6	8.2
Webber Upland	1925	1	100.0	10.0
Durango	1925	1	93.8	10.0

The main feature of the above table is the very low germinating power of Nyasaland No. 17 for the year 1926. There is no apparent reason for this. Examination of the seed showed a number to be completely shrivelled inside the testa, and others had been eaten out by insects, but both these causes were not sufficient to account for the very low germination.

Nyasaland No. 6 is very satisfactory, and its germination is rapid.

EFFECT OF SULPHURIC ACID ON GERMINATION.

The following test was made in 1926 to ascertain the effect on germination of cotton seed of immersion in sulphuric acid for varying periods of short duration. Seed was immersed in concentrated sulphuric acid (sp. gr. 1.84), for five, ten, fifteen, and twenty minutes, after which the seed was thoroughly washed in water and placed in a petri-dish. Controls were used, one lot of seed being soaked in water for ten minutes before placing in the germinating dish, and another having no treatment before placing in the dish. The results are summarized below:

TABLE XVIII.

<i>Treatment.</i>	<i>Germination Percentage.</i>	<i>Number of Days to Complete Germination.</i>
Control No. 1 (no treatment)	63.5	10
Control No. 2 (water-soaked ten mins.)	55	9
H ₂ SO ₄ (five minutes)	76	4
H ₂ SO ₄ (ten minutes)	81	4
H ₂ SO ₄ (fifteen minutes)	83.5	6
H ₂ SO ₄ (twenty minutes)	96	4

Immersion in H₂SO₄ thus appears to have a beneficial effect on germination and increases the rapidity of germination to a great extent. All treated seeds were completely defuzzed, and although with twenty minutes' immersion many seeds split, yet no ill-effect on germination occurred.

A subsidiary test on the germination of seeds floating on the surface of the acid showed low germination.

FLOATING SEED.

H ₂ SO ₄ , 5 minutes	..	..	..	32 per cent. germinated
" 10 "	..	..	..	33 " "
" 15 "	..	..	..	50 " "
" 20 "	..	..	..	76 " "

The use of sulphuric acid commercially in Uganda would not be worth while under present conditions as natives could not manipulate a seed drill effectively and there is no need for the use of one.

DEPTH OF PLANTING.

In order to find out the optimum sowing depth for cotton a glass case was filled with soil and seed sown at depths from $\frac{1}{4}$ inch to 5 inches, by quarter-inch intervals. At each depth germination and considerable root development were observed, but only with seed sown at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ inch did the cotyledons come above the surface. All the others gradually decayed.

CONCLUSIONS.

1. The above is a short report of the results of the writer's initial work as Cotton Botanist from October, 1924, to middle of 1926.

2. The work of selection has been started afresh—single plants selected in 1924-25 were grown in progeny rows 1925-26. Certain of these have been selected for growing in increase plots, 1926-27.

3. A number of single plants have been selected from the progeny rows of 1925-26, to be grown in progeny rows, 1926-27.

4. Selection has chiefly been made for quality of lint and quantitative characters indicative of high yielding capacity.

Certain selections, SG 15 in particular, have an excellent quality lint and are long stapled.

5. In 1924-25 and 1925-26 certain progeny rows and $\frac{1}{4}$ -acre plots—the result of selections made by the Senior Agricultural Officer—were examined, and a few were selected for a stop-gap until the production of a pure line has been accomplished.

6. A number of field experiments have been begun with the hope of obtaining an increase in yield per acre. Sowing date, spacing, and variety tests were carried out in 1925-26.

7. The programme of 1926-27 is an elaboration of that of 1925-26 (see Appendix I.).

8. No attempt has been made to analyze or draw conclusions from the results of plot experiments on account of their having been carried out for one year only.

9. Complete analyses from progeny-row data will be given in the report for next year.

10. Little laboratory work has been done owing to the fact that the laboratory was only completed on January 1, 1926, and also owing to the staff being so limited.

11. Germination tests have been made, the chief result being very low germination percentage of the strain No. 17.

12. Samples have been examined from most cotton-growing areas of the Protectorate. Most samples showed irregularity, and the staple indicates the need for a more regular and longer stapled strain of cotton.

13. Flowering curves of two progeny rows and of the sowing-date plots are given in Appendix IV.

Bolling curves of two progeny rows are also given.

APPENDICES

APPENDIX I.

PROGRAMME FOR 1926-27.

Selection work:

Progeny rows.

$\frac{1}{4}$ -acre increase plots.

F1 and F2 generations of various crosses.

Field experiments—*At Serere*:

Combined spacing and sowing date.

SPACINGS.

4	by 2 feet	..	..	..	..	1 plant per hole.
4	„ 2 feet	..	..	..	..	2 plants „
4	„ 1 foot	..	..	..	..	1 plant „
3	„ 2 feet	..	..	..	..	1 „ „
3	„ 1 foot	..	..	..	..	1 „ „

Five plots of each spacing to be sown in June, July, and August, making seventy-five plots in all.

Yield test of Nyasaland strains:

Five plots each of Nos. 6, 17, 19, and 24.

Ridging *versus* Flat planting:

Five plots to be sown on the ridge and five plots on the flat.

At Soroti, Nyero, Labori, Katakwi, Dokolo, Aduku, and Kabera-maido:

A trial of two spacings:

4 by 2 feet and 3 feet by 1 foot.

Five plots of each spacing.

At Simsa Plantation:

Spacing trial—Five spacings:

4 by 2 feet, 4 by 2 feet (2 per hole).

4 by 1 foot, 3 by 2 feet, and 3 feet by 1 foot.

Five plots of each.

At Ngetta Plantation :

Spacing trial—four spacings.

Strain trial—four strains.

At Busoba Plantation :

Similar to Ngetta.

APPENDIX II.

Technique.—In measuring the staple of cotton the quickest method combined with fairly good accuracy was found to be that of pulling out a tuft of hairs, placing it on black paper, and measuring the length by superimposing a glass ruler marked off in millimetres. This is admittedly not the most accurate method, but when time is limited it is found to be the most satisfactory.

For single plants ten seeds are combed.

For ordinary samples at least fifty are combed out after the sample has been well mixed, divided into small heaps, and seventy seeds picked out at random.

APPENDIX III.

Size of Plots.—In Uganda soil variation is considerable, and plots have to be replicated many times to ensure accuracy. Last year three and four replications of plots varying in size from $\frac{1}{6}$ to $\frac{1}{25}$ acre were used, but it has now been decided to adopt $\frac{1}{20}$ -acre plots repeated five times as a standard for cotton experiments in Uganda.

In most places the ground is scattered with large anthills, which makes the fitting in of plots a difficult process, especially long plots, therefore it has been decided to have square plots in all field experiments.

Each plot is divided from its neighbours by a narrow and shallow trench, and a similar trench surrounds the whole block of plots. Where necessary outside rows and plants are ignored. Picking is done weekly, and the produce weighed at each picking.

APPENDIX IV.

Flowering curves of the sowing-date plots are shown very diagrammatically in Fig. 1. One of the causes of August plots giving a low yield is clearly shown in this figure. Owing to late sowing only one short period of high flowering appears in the August plots as against two distinct periods for June and one long one for July. The August sowing curve, however, shows a very pronounced peak in February, and if these flowers could mature into bolls no doubt August would show a higher yield. The peaks and valleys of the three curves correspond, and when these are correlated with the growth curves and meteorological data curves, the causes of the dips will be shown.

Fig. 2 shows flowering and bolling curves of two progeny rows. SG 11 being a Salisbury Selection, and SG 15 being from a Nyasaland strain. Here again the curves closely correspond, though the flowering curve of SG 11 rises more rapidly and descends more rapidly than that of SG 15. The only period of non-fitting is in early December, where SG 15 shows a sudden rise in the rate of flowering which is not shown by SG 11. The total number of flowers produced by SG 11 was 1,673* as against 1,440* by SG 15.

The peaks of the bolling curve correspond to similar ones of the flowering curve if the former is brought back, fifty-six days in the case of SG 15, and forty-nine days in the case of SG 11. Thus it is seen that the strain SG 11 has a shorter period between flower and boll than SG 15.

There is no bolling at all to correspond with the second flowering period in February, as all bolls were shed owing to commencement of the rainy season.

Unfortunately it has not yet been possible to correlate these curves with meteorological and growth curves, but these will be presented in next year's report.

* These figures were obtained from fifteen plants of each variety.

FIG

FLOWERING CURVES

Flowers per plant per d

(Very

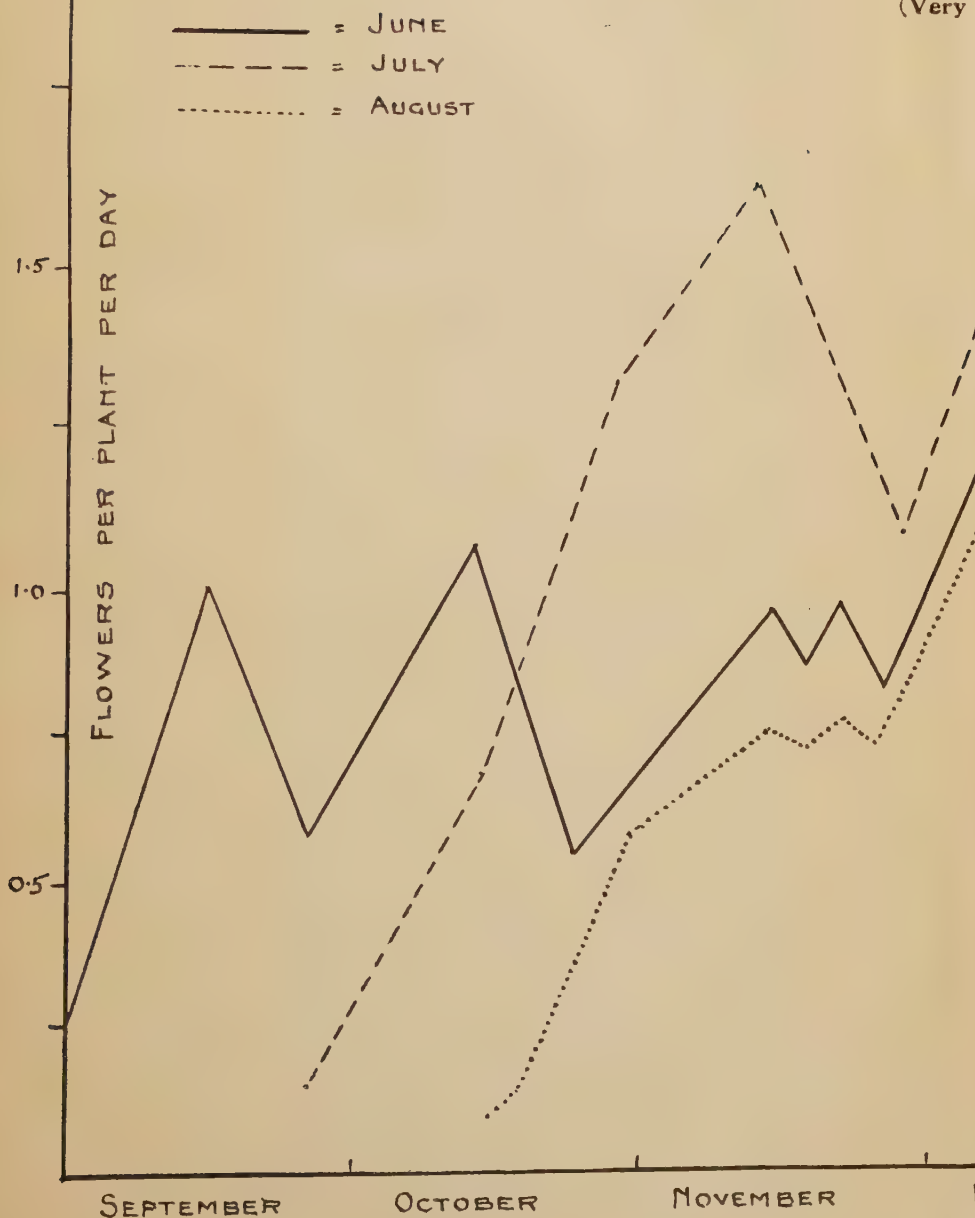
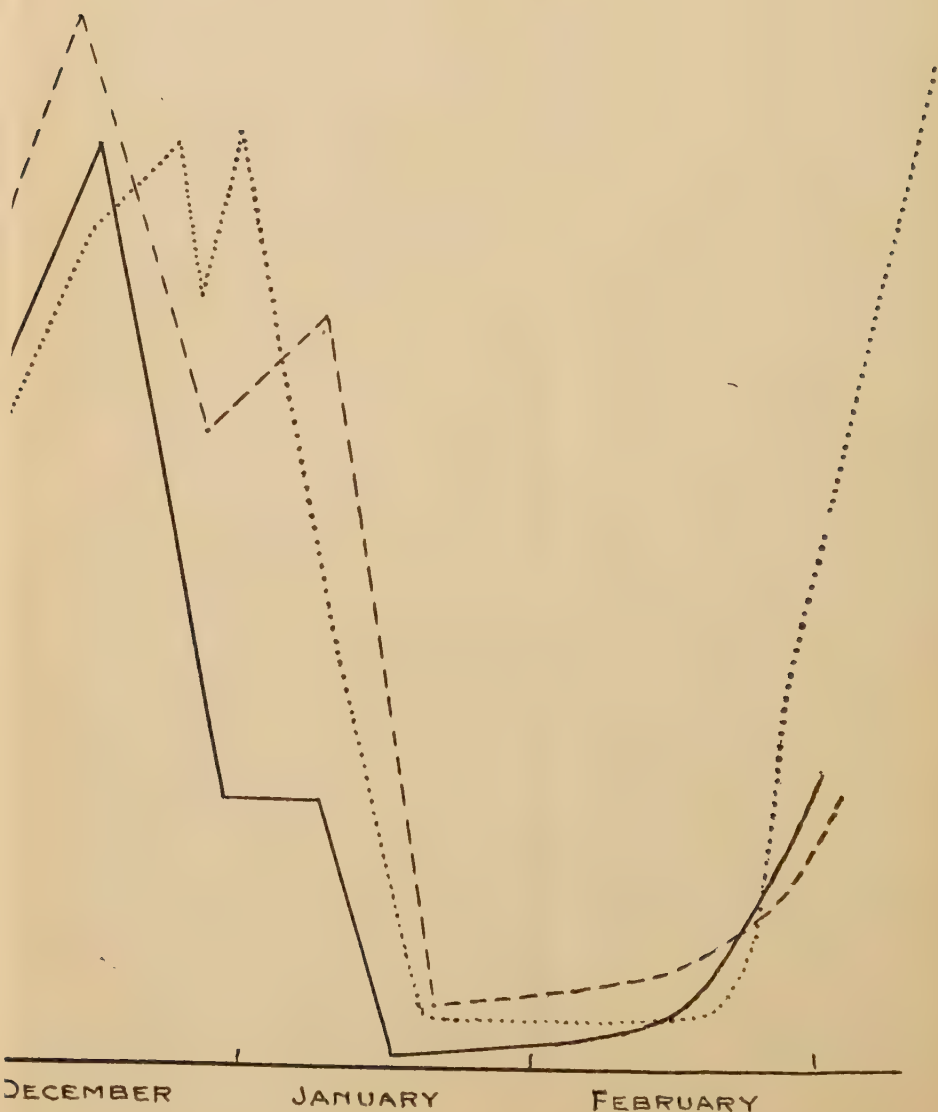


FIGURE I.

OF SOWING DATE PLOTS

ay smoothed to weekly means.

liagrammatic.)



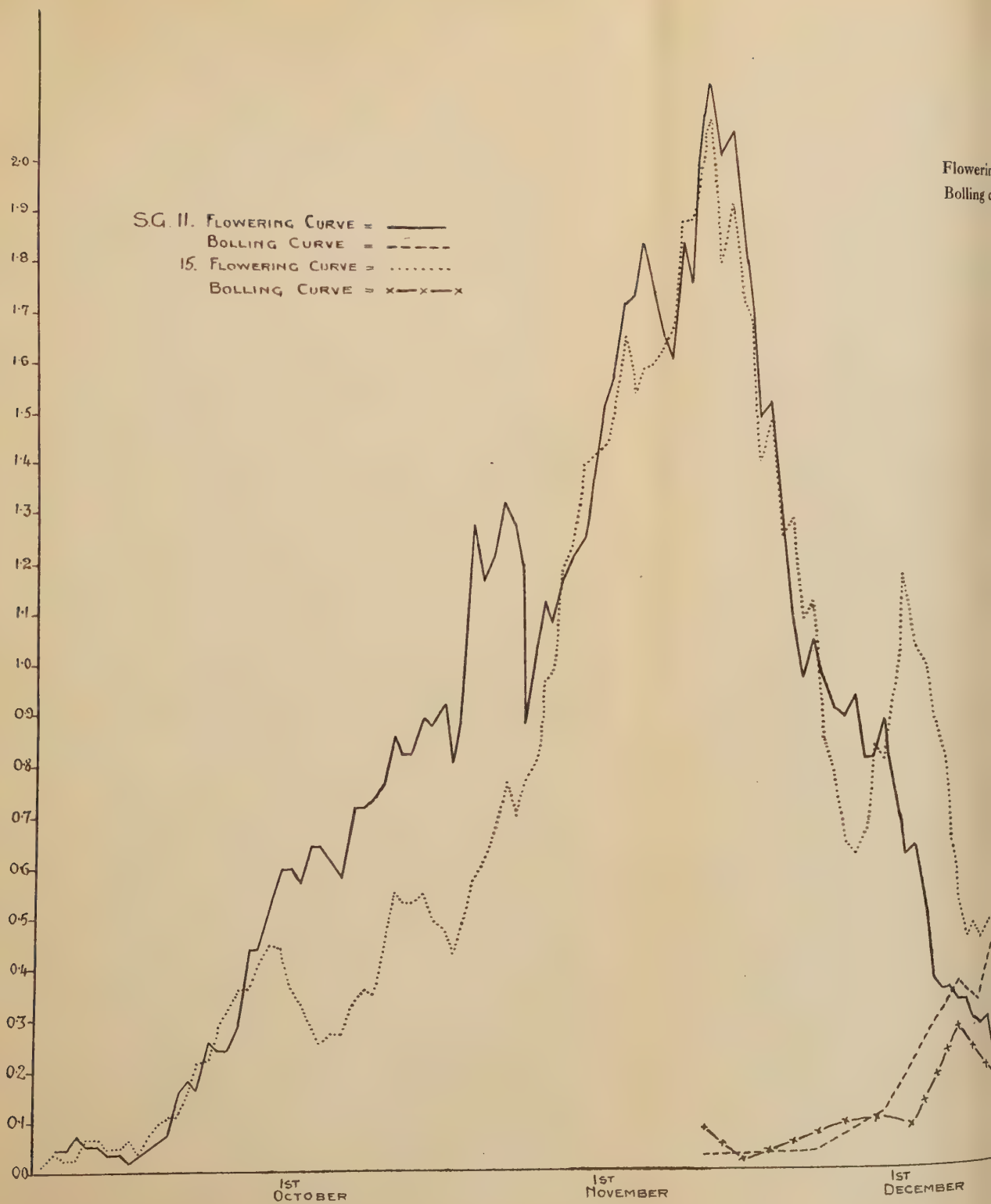


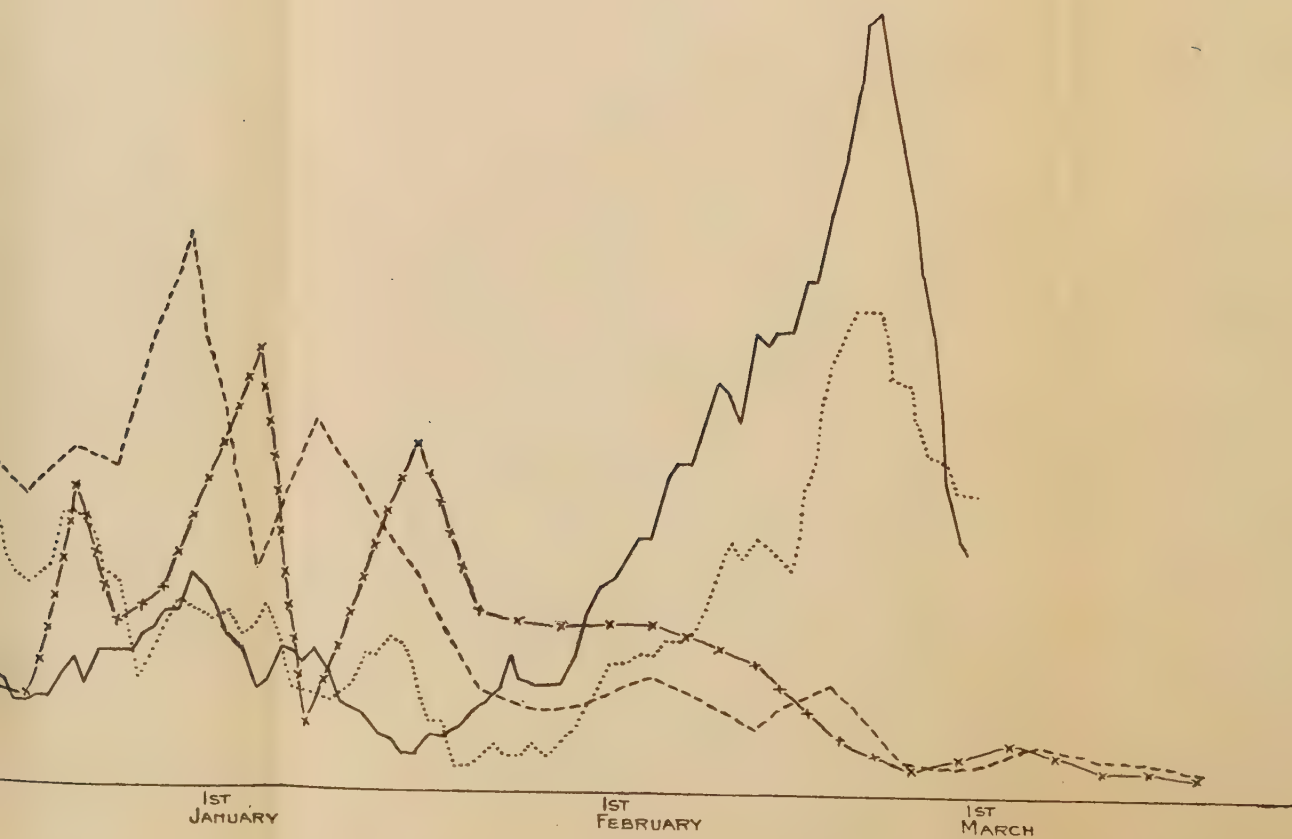
FIGURE II.

LOWERING AND BOLLING CURVES

PROGENY ROWS: SG 11 AND SG 15

curves = flowers per plant per day smoothed to five-day means.

ves = bolls per plant per day plotted on days bolls were picked.



NYASALAND

1.—REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, MAKWAPALA, FOR THE YEAR ENDING OCTOBER, 1925

BY

H. C. SAMPSON.

Season.—This, on the whole, was not favourable for cotton. The season commenced very late and it was not till the middle of December that the first rain was received. With the aid of this most of the cereals and some of the cottons were sown, but this was followed by hot, dry weather till the last day of the month, and any light showers which fell, though they may have moistened the atmosphere somewhat, evaporated before they could penetrate the soil. On the other hand, January and February were particularly wet, there being only ten days in this period when rain was not recorded, and during the whole of this time the weather was dull, cool, and the sky overcast. There was a short break in the beginning of March which made it possible to get the fields cleaned, but this was followed by more dull, cloudy weather till the middle of April, when the rains ceased abruptly. A statement of the rainfall is given in the accompanying table, the total for the year being 40·47 inches. The total rainfall received was not much above the average of the locality, but the distribution was very unfavourable. The most serious effect of this continuous dull weather was a very severe attack of bollworm, all three species—viz., the Red, the American, and the Spiny—contributing their share of the damage.

Rotations.—The main check to the progress of cotton cultivation in Nyasaland is the serious toll taken of the crop by bollworm. Such evidence as is available points to the fact that this pest is becoming increasingly serious, and this is not to be wondered at when one considers that the usual practice of the country is to grow cotton year after year on the same land and that the cultivation given to such land is of the scantiest, there seldom being more, and often less, than two months between the removal of one crop and the planting of the next. One of the main items of work on the cotton station is to try and find out what rotations are feasible and profitable. Here one

again comes up against the universal African problem of transport, both inland and for export. If cattle can be employed for the former, then it is not a serious item, as this form of transport is reasonably cheap, but most of the cotton areas are at low elevations and are frequently in "fly areas" where, though cattle may possibly be used on the plantation, they cannot be used on the roads. Where cotton areas are adjacent to river or rail transport even the more expensive mechanical transport can be used for short carries, and it is possible that many crops can be grown which would be impossible further away.

The cotton station is therefore worked on a definite system of rotations, which are described below.

The conditions are fortunately such that every annual crop grown in Nyasaland can be grown successfully at the station. The station is laid out in twelve fields of 5.4 acres each surrounding a buildings block also of 5.4 acres. All the fields are rectangular in shape, and their arrangement is as follows:

Nos. 1 and 10 form a two-course rotation of cotton and cereals.

Nos. 2, 11, and 8 form a three-course rotation of cotton, tobacco, and $\frac{1}{2}$ cereal, $\frac{1}{2}$ pulse.

Nos. 3, 12, and 7 form a three-course rotation of cotton, fibres, and $\frac{1}{2}$ cereal, $\frac{1}{2}$ pulse.

Nos. 4, 5, and 6 form a three-course rotation of cotton, oilseeds, and $\frac{1}{2}$ cereal, $\frac{1}{2}$ pulse.

No. 9 is used for planting test plots of various rotation crops and odd plots of cotton.

It is desired to carry on these rotations in their present form and on the same fields for as long as possible.

Records are being kept of all cultural operations, field observations on the crops, yields, and disposal of produce. These records are being kept on the daily record sheet system. The daily records are collated monthly, and all operations costed. The complete records are transferred to cultivation sheets, which are made up annually and filed for reference.

Rotation Crops under Trial.—A summary of the rotation crops at present under trial may be of interest. They comprise numerous varieties, both introduced and selected from the native crops, of the following:

Cereals ..	..	(Maize (<i>Zea mays</i>).
		Kaffir corn (<i>Dura</i>) (<i>Sorghum vulgare</i>).
		Bulrush millet (<i>Pennisetum typhoideum</i>).
		Finger millet (<i>Eleusine coracana</i>).

Pulses	{	Lima beans (<i>Phaseolus lunatus</i>).
		Kidney beans (<i>Phaseolus vulgaris</i>).
		Green gram (<i>Phaseolus mungo</i>).
		Dolichos beans (<i>Dolichos lablab</i>).
		Horse gram (<i>Dolichos biflorus</i>).
		Velvet beans (<i>Stizolobium spp.</i>).
		Cowpeas (<i>Vigna catjang</i>).
Fibres	{	Sunn hemp (<i>Crotalaria juncea</i>).
		Jute (<i>Corchorus olitorius</i> and <i>Corchorus capsularis</i>).
		Bimlipatam jute (<i>Hibiscus cannabinus</i>).
Oilseeds	{	Ground nuts (<i>Arachis hypogea</i>).
		Sesame (<i>Sesamum indicum</i>).
		Sunflower (<i>Helianthus annuus</i>).

All these crops are of possible value either as native food crops, export crops, locally consumed crops not for food, or green manures.

It is desired to ascertain the effect on the cotton crop of these various rotation crops both from the point of view of the cotton itself and of bollworm control.

Cotton and Cereals in Alternate Years.—The four common tropical dry-land cereals are grown—viz., maize, dura or giant millet, bulrush or pearl millet, and raggi or finger millet. To each of these a definite area is assigned in each of two fields, and in the alternate years a crop of cotton is grown, the rows of the latter running across the previous year's cereal rows. This should show what effect the cereal has on the following cotton crop, for experience in other countries has shown that such effect may be considerable on its yield. The necessity for including all these cereals in this rotation is that in many of the cotton areas the climate is too warm for maize to thrive well, and of the other cereals, it appears that certain tribes will eat one and not another. Thus the bulrush millet, which is one of the best cereals as a rotation for cotton, is hardly known and never eaten in the South Nyasa districts, yet it is one of the main food crops in the Lower Shire districts. This rotation, it is hoped, will give useful information for furthering the cultivation of cotton by natives and at the same time will assist estates to decide what cereal they can grow for feeding their labour. Such a rotation, however, hardly fulfils the requirements of a country where the market for such crops is strictly limited, and some other rotation crops, which may be expected to yield a profit, even though it may be small, have to be found. Thus three other series of rotations have been initiated. The basis of these is to include an additional money crop which

can be grown between the cotton and the soil recuperative crop of a cereal or a pulse. From the experience of this past season it seems possible that these rotations can be extended by the addition of catch crops. Thus in the following case, where tobacco is the succeeding crop to cotton, it may be possible to make this into a five-course rotation within the three years, as follows:

1st year	..	..	Cotton.
2nd year	..	..	{ 1st crop, Tobacco. 2nd crop, Chick pea.
3rd year	..	..	{ 1st crop, Maize or other short-duration cereal. 2nd crop, Field beans.

Cotton, First Year ; Tobacco, Second Year ; Cereal and/or Pulse, Third Year.—This rotation includes the other main export crop of Nyasaland. Until recently tobacco has always been considered as a crop specially suited to higher elevations. Possibly this may be the case with flue-cured tobacco, but there is no reason to suppose that other types of tobacco cannot be grown at lower elevations in the same way that they are grown in other countries. Where tobacco has been grown after cotton in Nyasaland, it is generally stated that the tobacco does very well.

Cotton, First Year ; a Fibre Crop, Second Year ; Cereal and/or Pulse, Third Year.—There are possibilities about a fibre crop, especially as there is a fairly big demand from the tobacco growers of the country for a soft twine for tying tobacco when being cured. It has agricultural uses as well. The crop is broadcasted, so that the plants are close enough together to prevent them from branching, and thus it is not only a cheap crop to grow, as it smothers weeds, but it can be looked upon as a cleaning crop for annual weeds. The main difficulty is in dealing with the crop when it is cut, on account of the limited supply of water in most areas for retting.

Cotton, First Year ; Oilseeds, Second Year ; Cereal and/or Pulse, Third Year.—There are two main tropical oilseed crops, which at once suggest themselves as a possibility for a profitable rotation crop—viz., Simsim or Sesamum and Groundnuts. The former is a cheap crop to grow, as the seed is broadcasted, and if sown sufficiently thickly it acts as a smother crop. The latter is more expensive to grow, but, if sown close enough together, weeding expenses are limited, as the crop soon makes a ground cover.

The season under review is the first where definite rotations have been possible, and even here a certain amount of trial has been

necessary to try and ascertain what particular species and varieties of these several types of crops can be grown. This must also of necessity be the case for more than one year, as it may be found that some of these crops have an adverse effect on the cotton crop which is sufficient to warrant their exclusion.

One field on the station has been reserved for trial plots of various possible crops and varieties of crops, which might be found more suitable in the rotations than those now being grown.

One obvious defect in these rotations, and one which cannot be corrected, is that it will seldom be possible to judge the yields of cotton, as this crop in the rotation will usually be experimental and will consist of small plots of single-plant selections, increase plots, and small bulks. The effect of the different rotation crops on the cotton can thus only be computed by careful observation.

COTTON—CEREALS ROTATION.

The following are the acre yields of grain obtained from the several cereals grown; each plot measured 1.35 acres.

Maize.—The variety when first introduced into Nyasaland some six years ago was Salisbury White, but it has crossed considerably since then. The crop was planted in 3-foot rows and spaced some 15 inches in the row, leaving two plants at a hill. The spacing was found to be much too close for the wet season experienced, and the plants were drawn up, growing to a height of 11 to 12 feet, while the height of the cobs from the ground was from 5 to 6 feet. The yield obtained amounted to 1,763 lbs. per acre.

Dura or Giant Millet.—The variety grown was a local one, the seed being purchased from native sources. It was badly mixed with other varieties. This was sown in drills 20 inches apart and the plants were thinned out to 9 inches in the row. The spacing was found to be too close for the wet season experienced and the crop grew to a height of 18 to 20 feet. The yield of grain obtained amounted to 2,253 lbs. per acre. This variety takes too long to mature and does not ripen until well into the dry weather. This is objectionable from a cultivation point of view, as the cultivation of the entire field should be as uniform as possible.

Bulrush or Pearl Millet.—The variety grown was a large-seeded, naked-grained one, the seed of which was obtained from the Chikwawa district. It is said to have been originally introduced there from the Zambesi. It is a strong-growing, early variety which tillers freely from the stool. This was sown in 20-inch drills and thinned

out to 9 inches in the row. This spacing seemed satisfactory. The yield of grain obtained was 2,431 lbs. per acre. This is an exceptionally heavy grain yield for this species of millet.

Finger Millet.—The variety grown was one which was imported from Mysore by the Agricultural Department in 1922. The seed of this was sown in nurseries and the seedlings, when ready, were pulled and laid along the crest of the plough furrow, the next furrow covering in the roots. The yield of grain obtained was 2,150 lbs. per acre.

The cotton crop grown in this rotation consisted of single-plant selections and small plots of newly imported strains and varieties. Thus no acre yields can be computed. The crop, however, was not good, as bollworm damage was very severe.

COTTON—TOBACCO—CEREAL AND/OR PULSE.

The tobacco crop was grown from seedlings raised on an adjoining estate. The seed beds were sown for mid-December planting, but owing to the lateness of the rains the crop was not planted till near the middle of January. By that time the seedlings were really too old and many had become woody. The land was check-rowed 3 by 3 feet for planting. Growth was very poor till the continuous rains broke in the beginning of March. The crop then made excellent growth and gave a yield of 1,179 lbs. of marketable strips for the field, or 218 lbs. of strips per acre. The curing was done for us on a neighbouring estate by the courtesy of the Blantyre and East Africa Company.

In the cereal and pulse field of this rotation half the area was planted with Giant Millet and the other half with pulses, half the latter area being under Lima beans and the other half under Tepary beans. In the millet half of the field three native varieties were grown—viz., Sumbwi, an early, close-headed, red-grained variety, which yielded at the rate of 2,862 lbs. of grain per acre; Kapile, a tall, late, loose-headed variety which yielded at the rate of 2,538 lbs. of grain per acre; and Namusi, another tall, late, loose-headed variety which yielded at the rate of 1,623 lbs. of grain per acre. These were all sown in 20-inch rows and thinned out to 9 inches in the row. The spacing was found to be too close for all except the early variety Sumbwi.

The Lima beans were sown as early in the season as possible after the rains had commenced. These made excellent vegetative growth and formed a splendid leaf cover, but failed to make a crop, and such crop as did form did not mature till October. The only place where any earlier cropping was seen was along the margins of

the field near the drains. It is presumed that the excessive soil moisture during the rains prevented the crop from seeding, as in the previous year a much later sown crop matured an excellent yield in July, though not sown till the end of January.

The Tepary beans were not sown till the end of January, but this was too early for the present season, as the crop, which only takes two and a half months to mature, had to be harvested before the dry weather set in. This yielded at the rate of 473 lbs. per acre. The seed was sown thinly in 20-inch rows.

The cotton crop in this rotation consisted of single-plant selections and small bulks of new importations, and therefore no figures of yield are available. The crop was very poor, however, on account of the damage done by bollworm. In this field all selections with a staple of over $1\frac{1}{8}$ inches were grown, and it was observed that these were not nearly so healthy as were many of the selections of cottons with a staple of between 1 inch and $1\frac{1}{8}$ inches. Many of them were discarded before they had commenced to form cotton, as they suffered from leaf-curl caused by the wet soil conditions and jassid attack.

COTTON—FIBRE—CEREAL AND/OR PULSE.

The field devoted to the cereal and pulse crops was sown half to maize, which yielded at the rate of 1,993 lbs. per acre, and half to Lima beans, which fared much the same as these did in the previous rotation and only gave a yield of 206 lbs. per acre.

The fibre crop consisted of Sunnhemp. This was sown broadcast at a rate approximating 50 lbs. of seed per acre at the end of December. The crop made excellent growth and formed a very useful smother crop. At the end of six weeks the crop was 4 feet high, and by the end of March was 8 to 9 feet high and in flower. This yielded seed at the rate of 930 lbs. per acre, and the yield of fibre was computed, from measured areas cut and retted separately, to be 1,000 lbs. per acre. This has promise of being a valuable addition to the crops of the country. It is a good cleaning crop, as it smothers weed growth. Its rapid growth makes it suitable for being ploughed in as a green dressing crop when from five to six weeks old. It is a leguminous crop and readily forms nodules on its roots. When grown as a fibre crop its leaves shed before the crop is ready for harvest, thus making a good leaf mulch on the ground and the land then ploughs up very well.

The cotton crop in this rotation was a bulk crop of "Over the Top" grown from newly imported seed. This was sown in 4-foot rows and the plants spaced singly at 18 inches apart. Sowing took

place on December 19 after the first sowing rain, and a very good germination was obtained. The dry weather following caused some anxiety and many of the seedlings had commenced to wilt off before another shower saved the situation. The result was that the ultimate stand was not quite full. The seed used was imported from America from the originator of this variety, and it was soon observed that this new importation was not nearly so pure as was the small trial crop of this variety grown in the previous season. The plant had, however, many of the characteristics for which this variety was selected out of several tested. More than 99 per cent. of the plants were jassid-resistant. In spite of the very wet soil conditions prevailing throughout January, February and March, the plant always remained healthy and vigorous. The leaf is large and the lower surface hairy. It is an early, even-flowering cotton. Later on the crop showed considerably more variation in growth habit. Many plants showed a cluster and semi-cluster habit. Others, again, had flowers with the dark red spot at the base of the petals. In the lint also there was great variation—from $\frac{3}{4}$ to $1\frac{1}{4}$ inches. A very considerable amount of roguing had therefore to be done in the field. Full advantage has been taken of this variation, and a large number of single-plant selections have been made.

As soon as the flower buds appeared on the crop the Red Bollworm commenced laying eggs in large numbers on the plant. An attempt was made to cope with the pest by picking off all flower buds which had flared—*i.e.*, the bracts had opened wide—a sure sign that the bud has been damaged by insect attack. This was done systematically at intervals of a few days, but the growth of the crop was so rapid that after five weeks of this hand-picking it was found impossible to do it efficiently. However, it looked at that time as if the crop was safe and possibly it would have been from the ravages of the Red Bollworm, but the American Bollworm then made its appearance in pest conditions of a severe type, and the combined ravages of these two, in which the Spiny Bollworm assisted, spoilt all prospects of getting any adequate yield, and only 93 lbs. of seed cotton per acre was obtained, not including that picked separately from selected plants.

COTTON—OILSEEDS—CEREALS AND/OR PULSE.

The field devoted to cereals and pulses in this rotation was sown half to Velvet beans and half to Bulrush millet. This was the area where cotton had been planted the previous season and previous to that it had been native gardens. The half of the field where velvet beans

were planted was full of weed seeds, and this crop was selected as being a soil recuperative crop. It made excellent growth and yielded at the rate of 1,455 lbs. per acre of beans. It was intended to plough this crop in, but its growth was so rank that this was not feasible. The variety of Bulrush millet grown here was one imported from India by the Agricultural Department in 1922. It did not prove as satisfactory as the variety grown in the first rotation. It did not ripen evenly and it formed subsidiary shoots and ears from the nodes of the main tillers. The grain was small and the glumes adhered to the grain when threshed.

Oilseeds.—Half of the field was sown broadcast with Sesamum, the seed being obtained from a native source from the Chiromo district. The seed rate adopted was about 3 lbs. per acre. If anything this was too thick, but the crop in spite of this made excellent growth and smothered all weeds. The yield obtained amounted to 390 lbs. per acre, which is not satisfactory. This low yield is partly explained by inexperience in handling the crop at harvest time, as the seed is very apt to shed when the pod is ripe. It was intended to plant the other half of the field with groundnuts, but it was not possible to procure sufficient seed. A little over half an acre was planted with the large-seeded native variety known as Chimbuwila. This was planted in 14-inch rows and about the same distance apart in the row. It is a spreading variety and covered the ground in about two months, thus reducing the cost of weeding. An acre yield of 1,600 lbs. per acre was obtained.

A little over an acre was planted with seed of the Spanish bunch variety, which, as its name implies, is of erect habit and only forms its nuts from near the crown. This never made a complete cover, and consequently weeding charges were higher. The plant does not keep as healthy as the local variety, and quite a number of them wilted off before the crop ripened. The yield was only 940 lbs. per acre.

Both varieties ripened at about the same time, in four months from the time of sowing. In India this is always reckoned to be a five-month crop for all running varieties and four and a half months for bunch or erect varieties.

A little over an acre was planted with sunflowers. This developed about 5 per cent. of multiple-headed plants, which were rogued out. The yield obtained amounted to 1,360 lbs. per acre.

The field allotted to cotton in this rotation was sown partly with small bulks of single-plant selections and the rest of the field with "Over the Top." The yields were insignificant on account of boll-worm damage.

MISCELLANEOUS TRIAL CROPS.

Five white varieties of maize, three dent and two flint, were grown. These were Potchefstroom Pearl, White Horse-tooth, Wisconsin, White Botman, and a flint corn from Kenya. Of these Potchefstroom Pearl seemed to suit our conditions best. The cobs averaged 0.45 lb. in weight of grain and the percentage of cob to grain was only 16.3 per cent.

Several varieties of Sorghum were grown, including three selections from the Lower Shire and six of Indian origin. None of the Indian varieties appeared suitable to this country. These were close-headed varieties, which in the heavier rainfall experienced here, could not dry out sufficiently to mature their grain properly. All of them were much more liable to rust than any of the local varieties tried on the station.

Three indigenous species of *Crotolaria* were grown to see whether they were suitable for fibre production. In all cases their early growth was much too slow and their cultivation would have meant very heavy weeding charges. None of them gave as good a fibre as the sunnhemp. Two of them looked as if they might prove useful as a green dressing crop for tea.

Seed of the wild *Hibiscus cannabinus* was collected and grown. The seed, however, was not too good and the germination was sparse, and the plants were thus able to branch freely. This gave a very nice sample of soft fibre when retted while the seed pods were still tender.

Two samples of jute seed were obtained from Bengal—viz., *Corchorus capsularis* and *Corchorus olitorius*. These made promising growth and gave a good sample of fibre when retted while the crop was in flower.

A collection was made of the different native varieties of finger millet and small plots of these were planted out. They were found to be badly mixed, but apparently there are some quite useful heavy cropping strains of this. These have been separated out for further trial this coming season.

Oilseeds.—Two varieties of groundnut were grown—one a small sample of Spanish bunch from Southern Rhodesia and the other a sample of Virginia bunch from the Transvaal. Sufficient seed was saved of these to make comparative trials this coming season. Half an acre of a local variety of Simsim was grown. This gave a much better return than the variety grown in the main field rotation

crops and also gave a much better sample of seed—a bright, white sample.

Pulses.—Collections were made of native varieties of Cowpea and of the field Kidney bean. Of the latter there was considerable variation in habit and cropping capacity.

Samples of Green gram of native origin were also grown, which were distinctly promising both from the point of view of a pulse crop as well as a green dressing crop.

The crops grown in this field have been of distinct educative value, not only in ascertaining what the country is capable of producing, but in collating information about these crops from native sources. Some idea has now been formed as to the proper sowing season for many of these crops and the possibility of growing catch crops. It is all groundwork for the improvement of native agriculture in general and of native cotton cultivation in particular. Nature is so lavish in this country that native agriculture is in a very backward state, and with the increasing interest which is being taken by natives in cotton cultivation the time is not far distant when better and more permanent farming methods will have to be adopted. The time is fast approaching, especially in the Lower River districts, when shifting cultivation must cease and proper and permanent holdings will have to take their place. Unless this is kept in view, the time is not far distant when money crops such as cotton will encroach on the supply of food grains. At the moment the native idea is to make a clearing specially for his cotton, and on this he continues to grow cotton till the land no longer yields sufficient to compensate him for the labour expended. This then means clearing new land.

COTTON NOTES.

Treatment of Seed with Concentrated Sulphuric Acid.—All cotton seed obtained from outside sources for sowing was this year treated with concentrated sulphuric acid. The seed was placed in a suitable receptacle and stirred up with the acid till all the fuzz was dissolved off. This takes from five to ten minutes. The acid is then strained off and the seed washed three or four times in copious supplies of water, the last washing being done in water containing lime so as to neutralize any free acid remaining. The same acid can be used four or five times. The seed after the last washing is then spread out to dry, and any which is damaged can then be picked out before sowing.

This treatment is of great advantage when dealing with small lots of experimental seed. Germination is more rapid and the chances

of getting a full stand are therefore more secure, especially in countries where rains follow prolonged dry weather and where it is necessary to utilize early rains for sowing. If the seed is sown in a moist seed bed, the seedlings will show through the ground on the third day after sowing, and on the fourth day there should be a full stand. It was noticed this year when a drought followed after sowing, that where seed had not germinated, much more damage was caused by small rodents and millipedes where undressed seed was sown than where the seed had been treated with acid. It is possible that the acid destroys any properties in the seed coat which attract such pests.

Seed which was dressed with acid a year previous to sowing was found to germinate as freely as freshly dressed seed.

The Effect of Bollworm Damage on the Growth of the Cotton Plant.—It was very noticeable this season that, where bollworm attack was severe, every effort was made by the cotton plant to replace the damage done. Where the crop develops free from bollworm damage, one expects to find that, as the bolls commence to swell, the vigour of the vegetative growth declines in a marked degree. This, however, is not the case where bollworm attack is severe. The main stem, as well as both the monopodial and the sympodial branches, continues to grow and the internodes are longer. As many as sixteen flower or boll scars have been counted on one sympodial branch. This has given the plants, where they had space for free development, a curious appearance, as they formed a regular curtain of sympodial branches which trailed along the ground. At the close of the rains, when the bollworm commenced to disappear, the plants developed a top crop from the small sympodial branches near the apex of the main shoot, but soil moisture was insufficient to mature this.

The Effect of Saturated Soil Conditions.—On account of the continuous wet weather from the commencement of January till nearly the end of March, the soil was more or less saturated with moisture throughout that period. There was a marked difference in the way that different strains of cotton stood this. All smooth-leaved cottons developed the appearance of severe jassid attack, their leaves turning red and curling towards the under surface. The "Over the Top" strains, several strains of "Trice," a selection of rough-leaved "Cleveland" obtained from the Coker Pedigreed Seed Company, and a few single-plant strains of Nyasaland Upland, remained remarkably healthy, while individual plants in other new introductions behaved in the same way. The wide spacing of 4 by 4 feet which we had adopted for all our single-plant selections accentuated the effect of such wet soil conditions. Several single-plant selections of a Foster-

Whitehall cross obtained from Mr. Ewing of Scott, Mississippi, which were grown at this spacing suffered severely, though an adjacent field crop of the same strain of cotton, and grown from freshly imported seed sown in 4-foot rows and spaced at about 15 inches in the row, did not show nearly so much damage. It is presumed that the root system of the closer planted crop was able to take up more moisture from the soil and therefore improved the drainage.

At the cessation of the rains there was a marked falling off in the vigour of the crop. Within a short period the plants shed their leaves in spite of the fact that a surface soil mulch had been formed. This is attributed to the root system not being able to penetrate the soil sufficiently to withstand drought. Last season, which was comparatively dry, there was no such rapid loss of vigour. Later on the plants recovered somewhat, and it is presumed that they managed to get their roots down to the moisture. They commenced to make secondary growth fairly vigorously towards the end of July.

2.—REPORT ON THE WORK OF THE COTTON EXPERIMENT STATIONS, NYASALAND, FOR THE YEAR ENDING OCTOBER, 1926

BY

H. C. DUCKER.

THE STATIONS.

DURING the latter part of 1925 two small sub-stations were opened in order to supplement the work being carried on at Makwapala. The period under review therefore includes work done at these stations in addition to that at the central station.

The sub-stations opened were as follows:

Liwonde.—This is situated on the Upper Shire about thirty miles from Makwapala at an elevation of about 1,600 feet above sea-level.

The station was laid out on an area of black cotton soil a short distance from the River Shire. The area cleared consisted of ten acres in the form of a rectangular block, and was divided into four fields of 2·5 acres each.

Port Herald.—This is situated on the Lower Shire about one hundred miles from Makwapala and about one mile from Port Herald township. It is at an elevation of about 115 feet above sea-level.

The soil is a deep sandy alluvial loam and of a type much in favour with native cotton-growers.

The area cleared and the lay-out were both the same as for Liwonde. Both sub-stations were placed in charge of native overseers, the work being controlled by members of the European staff, who made visits at suitable intervals.

Acknowledgment is due to the B.C.G.A. for their assistance in connection with the Port Herald Station during the early part of the season, and to the District Resident, Liwonde, for his assistance with the station at this centre.

SEASON.

Makwapala.—In spite of a rainfall some 20 inches in excess of that experienced last season, this year has not been unfavourable to the growing of cotton at Makwapala.

There can be little doubt that this was due to the favourable distribution of rain, together with a very considerable amount of sunshine as compared with last season during the critical periods of the plant's development.

The rains broke during the last week of November, and planting was well advanced before the end of the third week in December. The crops were therefore given an excellent start, and did not lose this advantage even though the January rainfall was exceptionally heavy and continuous. February and March had what is probably but slightly above the average amount of rain for these months, and this was well distributed with an abundance of sunny intervals. April 1 was the last day on which a heavy shower occurred, and the weather after this date, up to the onset of the cold weather, was, for the most part, warm and sunny, the only rain which fell being light showers of short duration.

Liwonde.—The season at Liwonde was very similar to that experienced at Makwapala, except that the March rainfall was somewhat less.

Port Herald.—The rainfall at this station ceased much more abruptly, and was some 10 inches less than in the 1924-25 season. Good planting rains were, however, experienced, and fair rains fell during the period June-August, when light rains are usually expected in the Lower Shire District. Altogether it has been a good average season for this station.

The tables of rainfalls (Appendix I.) show the distributions and totals during the past two seasons at Makwapala and at Port Herald.

The graphs of temperatures and rainfalls at Makwapala and Liwonde (Appendix II.) cover the main flowering and fruiting period for cotton at these two stations, and the close resemblance between these two places as regards climate is clearly shown.

The graphs for Zomba and Port Herald (Appendix II.) are averages over the past five years.

MAKWAPALA.

General.—The work at this station followed, broadly, on the lines laid down in the season 1924-25 described above.

The various rotations were carried on into their second year and are discussed in detail below. The cottons sown were also the same as those of the previous year, no new introductions being made.

With the heavy rainfall which was experienced this season the soil erosion problem became very acute, and in order to combat this a contour survey was made of the whole cultivation area with a view to applying remedial measures.

Additions were made to the buildings in the shape of a set of brick bins for the storage of grain crops, since weevil and grain moth damage was found to be serious in its effect on the stores which are maintained

for feeding the native labour and for supplying seed stocks. A further addition was a ginning floor for the hand gins in order to facilitate the safe handling of seed from bulk sowings of selected cottons.

All the farm buildings were re-thatched during the dry season, and a certain amount of painting, and whitewashing done where necessary. The cattle were used for the first time in this season for the inter-cultivation of various crops, including cotton, and may now be considered to have reached a very fair state of training. A record was established during the ploughing season, when three pairs of bullocks, each with a Mysore plough by Ransomes, Sims, and Jeffries, broke 3.6 acres of ground in two days of eight hours each. This meant that well over half an acre of ground was ploughed per pair per day.

With regard to implements, no additions, other than a spring tine cultivator, were made to the stock of simple implements used in the previous year.

It cannot be said that a marked effect has yet been shown by the various rotation crops on the cotton grown, but this is hardly to be expected while the station is yet so young, nor has their effect as a means of controlling Red Bollworm been very evident, though from reports from elsewhere in conditions similar to Makwapala it does appear that the bollworm population is less on the station.

ROTATIONS AT MAKWAPALA.

The cropping scheme for this season was as follows:

	<i>Field</i>	<i>Field</i>	<i>Field</i>
Rotation I.	1. Cotton	10. Cereals	—
„ II.	2. Cereal-pulse	11. Tobacco	8. Cotton
„ III.	3. Cereal-pulse	12. Cotton	7. Fibres
„ IV.	4. Cotton	5. Oilseeds	6. Cereal-pulse
Miscellaneous Block: Field 9, Miscellaneous crops and cotton plots.			

The rotations described in the 1924-25 report are therefore carried on into their second season, the only difference being that fields 2 and 3 were sown with a main-crop cereal followed by a catch-crop pulse instead of the cereal break in these rotations being half cereal, half pulse, as last season.

Rotation I. : Cotton, Cereals. Field 1, Cotton.—This was sown as an increase plot with seed from the second importation made from the U.S.A. of "Over the Top," now designated as strain "B." The first planting was made on December 1, sowing three seeds per hole at a spacing of 4×2 feet. Germination was poor, and the field was supplied on December 14 at four seeds per hole. On December 28 the field was resupplied at four seeds per hole.

The earliest sown cotton was budding freely by January 6, and

Red Bollworm commenced to make its appearance at about this date. The cotton was thinned to one plant per hole on January 13, and the average stand calculated by counting the plants in a scatter of rows. This came out at only 40 per cent. of the possible total, and cannot be described as good. The seeding conditions were throughout very good indeed, and the poor stand can only be ascribed to bad seed. A considerable amount of the seed sown had been treated with concentrated sulphuric acid, about which treatment a note is appended at the end of this report.

The first picking was commenced on May 1, harvesting was complete by July 15, and the cotton was uprooted on July 20. The total yield was 230 lbs. seed-cotton per acre, of which approximately 60 per cent. is clean white cotton.

Field 10, Cereals.—This field was sown with the four main cereals of the country, one-quarter with each cereal.

Maize (Zea mays).—The variety sown was Potchefstroom Pearl, the seed being obtained through the Department of Agriculture from Southern Rhodesia.

This was sown on December 12 at a 4×2 feet spacing, two plants per hole, and an excellent stand was obtained. The crop was cut on April 12, stooked in the field, and allowed to dry out. When dry the cobs were harvested, weighed, and stored, and the straw stacked for use as cattle fodder. The yield obtained was 4,565 lbs. in the cob, about 2,708 lbs. grain per acre.

Mapira (Sorghum vulgare).—The variety sown was the native variety, Sumbwi. This was sown with the drill in 30-inch rows on November 30, and thinned to 9-inch in the row. Growth was much the same as in the previous season, except that with the heavier rainfall experienced this year attacks of sorghum rust were rather noticeable.

Harvesting was done on April 14, the yield obtained being 1,392 lbs. of grain per acre.

Macheweri (Pennisetum typhoideum).—The variety sown was the same Lower River strain which was sown in the previous year. The spacing adopted was the same as for the Mapira, harvesting was done by cutting, and stooking as for the maize. The crop matured about a week earlier than either the Mapira or the maize. When dry, the crop was stacked to await threshing.

Maweri (Eleusine coracana).—The variety sown was the same Indian strain as last year. This appears to be the same as a native variety known as Mphazi la Mkango. An attempt was made to obtain a stand of this cereal by drilling the grain in 20-inch rows on November 30. This sowing was a complete failure, and nurseries were sown

on December 10, from which seedlings were obtained and planted behind the plough on January 22. An excellent stand was obtained from the second planting. Harvesting was commenced on May 1. The yield obtained was 2,078 lbs. grain per acre.

Generally speaking, it was considered that under this season's conditions Mapira was the poorest cereal, while there was not much to choose between the other three from the point of view of yield.

Rotation II. : Cotton, Tobacco, Cereal-Pulse. Field 2, Macheweri (Pennisetum typhoideum).—This was the same variety as that sown in the cotton-cereals rotation, and its behaviour and treatment were the same. Threshing had not been completed at the time of writing, and the yield is therefore not yet known.

After harvesting the Macheweri, the land was ploughed and Green Gram (*Phaseolus mungo*) sown as a catch crop. This was practically a failure and the yield obtained was negligible. It appeared that the date of planting was too late for the present season.

Field 11, Tobacco.—The variety planted was Hickory Prior, seedlings being obtained from the estate of the Blantyre and East Africa Co., Ltd., which is close to the station.

Planting was done on January 11 and 12, only a fair stand being obtained. The plants were spaced 3×3 feet, and were grown on the flat. Growth was slow during the early stages, but with the sunnier weather which followed in February and March the crop made headway and a fairly even growth resulted. The yield obtained was 2,100 lbs. of graded leaf of the bright cigarette type, approximately 400 lbs. per acre.

As in the previous season, the crop was cured by the courtesy of the Blantyre and East Africa Co., Ltd., on their neighbouring estate at Naisi.

Field 8, Cotton.—This field was sown with a strain of Foster-Whitehall from Scott, Mississippi, now designated as strain G. As with field 1, this was intended as an increase block. Owing to the same difficulties with bad seed as were experienced with strain B, only a very poor stand was obtained after two resowings, amounting to only 35 per cent. of the possible total.

As a small increase plot in the previous season, this strain had been relatively free from Jassid damage. This season, however, the field was almost a complete failure from this cause, and the yield obtained was quite negligible, being only 180½ lbs. seed-cotton from the whole field.

It was noticeable that the progeny rows sown with selections from this strain, made in the previous season, and grown in field 9, within a few yards of this field, were noticeably free from Jassid damage,

indicating that relatively immune types exist within the strain and may be isolated.

Rotation III. : Cotton, Fibres, Cereal-Pulse. Field 3, Maize.—The variety sown was the same as that sown in field 10, and its treatment and behaviour were the same. The yield amounted to 16,542 lbs. on the cob.

After harvesting the maize, the field was ploughed and planted with Tepary beans (*Phaseolus acutifolius*). As with the Green Gram in field 2, it appeared that the date of planting was too late, since the yield obtained was negligible. It seems possible from our experience this season and last that these two pulses need to be sown before the heavy rains have quite finished if they are to succeed as catch crops.

Field 12, Cotton.—This field was sown with all the progeny rows from the various shorter-stapled selections made in the previous season and with various increase plots from the same strains. No figures are available in time for this report in connection with these plots.

Field 7, Fibres.—The fibre crops grown this season consisted of Sunn hemp, jute (*Corchorus olitorius*), and jute (*Corchorus capsularis*). One-third of the field was sown with each.

The sowing of all was done on December 2 and 3, and the same method adopted for all. The seed was broadcasted and bush-harrowed in, no further cultivation being needed, since growth was so rapid as to smother all weeds. Trial rettings were taken of the jutes as soon as flowering became general, about the middle of February. These gave very good clean samples of fibre which retted quickly. Subsequent rettings were progressively inferior in colour and took longer to ret.

Trial rettings of Sunn hemp were commenced as soon as the seed-pods commenced to form, and subsequent rettings up to the time of harvest, when the seed was ripe, were all of good quality. The fibre appears to be unaffected by being kept in the stack as unretted straw.

It appears that with the jutes it is necessary to ret the whole crop while in the flowering stage, a most difficult thing to do with any large quantity, while the Sunn hemp can be stacked and retted when required, thus making it a far easier crop to handle.

Small areas were cut and yield estimations made. These indicated in the neighbourhood of 1,000 lbs. clean fibre per acre for the Sunn hemp, but only about 500 lbs. per acre for the jutes.

Most of the jutes was harvested for seed, which is to be passed to the Department of Agriculture for trial in certain swamp areas in the Protectorate. The samples of the fibres from the various trial rettings are being sent to England for examination and valuation.

Rotation IV. : Cotton, Oilseeds, Cereal-Pulse. Field 4, Cotton.—An increase plot of 3.8 acres of "Over the Top," strain B, was sown in this field, and 1.5 acres of the first importation of "Over the Top," designated as strain A, was sown in the balance of the field. The latter was an almost complete failure, due to the bad seed from the 1924-25 crop, while the former only gave a 46 per cent. stand. In addition, the strain B plot was backward, due to the failure of the early sowings, and so met the brunt of the severe bollworm attack in late March and in April.

The yield obtained was only 270 lbs. seed-cotton of B and 33 lbs. seed-cotton of A.

Field 5, Groundnuts.—Of the half-field planted with this crop, 1.9 acres were sown with the native variety called Chimbuwila, and the remainder sown with Spanish bunch.

The yields were as follows: Chimbuwila, 1,302 lbs. per acre; Spanish bunch, 1,370 lbs. per acre. The difference is probably not significant.

Sesamum.—The other half of this field was planted with the white variety of this crop obtained from natives on the Palombe in the previous year and sown as an observation plot.

The seed was sown broadcast at the rate of $4\frac{1}{2}$ lbs. per acre, and the young plants thinned by means of a spring tine cultivator. A very well-spaced and even stand resulted. The yield, however, was disappointingly low, being only 433 lbs. gross, about 160 lbs. per acre.

It seems probable that a wet season like the one experienced does not suit this crop. It is, however, an exceedingly easy and cheap crop to grow, since no weeding is required.

Field 6, Sorghum.—Half the field was sown with sorghum as for field 10, and the same remarks apply. The rainfall effect in encouraging rust was even more marked in this field, which is comparatively low-lying and wet, and the yield obtained was only 1,637 lbs. grain, 606 lbs. per acre.

Lima Beans.—The remaining half of this field was sown with Lima beans, the variety used being that sown in field 12 in the previous season.

As in last season the yield was negligible, being only about 125 lbs. per acre, and since better strains have now been obtained it is not intended to cultivate this variety in the future.

Miscellaneous Block, Field 9.—In the current season, in addition to the plots of possible rotation crops, a part of this field was used for the longer-stapled cotton selections sown as progeny rows and small increase plots.

As regards the rotation crops, it is considered necessary to mention only the more promising crops which it is intended to incorporate in the rotation crops used in the main rotations. These are all long-term pulses which have shown promise of being valuable rotation crops.

They are as follows:

Lima Beans (*Phaseolus lunatus*): Five trailing varieties and one bunch variety from the Department of Agriculture.

Pigeon Pea (*Cajanus indicus*): A local variety usually grown as a perennial, which promises to be useful as an annual sown in close spacing.

Velvet Beans (*Stizolobium spp.*): One white-seeded trailing form and one bunch variety, the latter from the Department of Agriculture.

In addition to the above a number of pulses, together with a considerable range of native cereals and other crops which were grown, are being carried on to next season for further study.

LIWONDE.

The clearing of this station was commenced in the dry season of 1925, and completed in time for the sowing of the various crops.

As mentioned above, the lay-out consisted of four fields each of 2.5 acres. These were laid out in a two-course rotation of cotton and native food crops, two fields being devoted to each break of this rotation.

The crops sown were as follows:

		<i>Acres</i>	<i>Yield</i>
Cotton	.. "Over the Top" Strain B	5, of which 2.5 failed	600 lbs. seed cotton
Macheweri	As for Field 2 (Makwapala)	1.25	962 lbs. in head
Maize	.. Salisbury White	1.25	1,350 lbs. on cob
Sorghums	.. Native varieties: Sumbwi	0.625	690 lbs. in head
	.. Ngonkho	1.25	1,441 lbs. in head
Lima beans	As for Field 6 (Makwapala)	0.625	172 lbs. unshelled

The 2½ acres of cotton which failed were flooded out, and, owing to labour difficulties, it was impossible to drain the flooded area in time to save the crop.

All the rotation crops would have grown better had the land not been so new. This was particularly noticeable with the Macheweri, which failed to a considerable extent to set seed. Similar behaviour had been noticed on the part of this cereal at Makwapala in its first season.

In spite of the difficulties which were encountered, sufficient experience was gained to justify the abandonment of this station

owing to its close resemblance to Makwapala, and this decision was strongly supported by the comparative rainfall and temperature records for the two stations, covering the main period of fruiting and bolling of cotton at both.

In addition, in view of the desirability of exact and continuous records of the cottons grown, it was considered desirable that work should be concentrated on stations under the direct control of the European staff, since it is essential that such records be kept continuously and scrupulously. These natives cannot be trusted to do without a European in charge who lives near and is always close to the work.

While it is not insisted that conditions at Liwonde are exactly the same as those at Makwapala, it is confidently asserted that such differences as may exist are merely intermediate between those of the latter station and Port Herald.

PORT HERALD.

This station was cleared at the same time as Liwonde, and laid out and cropped in the same way.

The cotton sown consisted of 5 acres of "Over the Top," strain B, and with a shortage of seed, and poor quality at that, only a poor stand was obtained, which was certainly not more than 20 per cent. of the possible total. The yield obtained up to September 30 was 700 lbs. seed-cotton, and there is promise of at least half as much again.

The native food crops consisted of:

Macheweri	..	As for Field 2. (Makwapala)	2.5	acres
Sorghums	..	Native varieties: Sumbwi	0.625	"
		Ngonkho White glumed	0.625	"
		" Black "	0.625	"
		" Awned "	0.625	"

The yields of these crops are not at hand at the time of writing.

As regards the cotton, the planting date adopted was the intermediate date during the period in which cotton is sown on the Lower Shire—namely, about February 15.

It was increasingly obvious during the season that the growing conditions in this district are very different from those of the Upper Shire and the higher country generally.

It seems probable that the native is quite right in planting late so as to make cotton a cold-weather crop, which means, in Nyasaland, a dry-weather crop. The growth of the "Over the Top" at Port Herald which was sown in February closely resembled its growth at

Makwapala when sown as a rainy-season crop, except that its development was slower and that there was a pronounced tendency with some of the plants to develop a cluster habit. There was no indication that the later planting was giving a lower ginning percentage. Samples taken from the three stations of the "Over the Top," B, and ginned on the same gin by the B.C.G.A. gave the following results: Makwapala, 31.36 per cent., Liwonde, 30.77 per cent., and Port Herald, 31.57 per cent. It seems improbable that these differences are significant.

The time to the first picking was five months at Makwapala and Liwonde, and five and a half months at Port Herald, all dated from the time of sowing.

The most interesting and practical observation made, however, was that, under this season's conditions, which can in no way be considered out of the ordinary, the insect pests, which had been numerous and causing much damage up to July, began to decrease in number during this month, and by the middle of September had practically disappeared. Not only were all species of bollworm practically absent, but stainers (*Dysdercus*) were present in only very small numbers. All the cotton picked at this time was of excellent quality. Identical conditions were found in the case of the native cotton grown on gardens in the neighbourhood of the station.

It has been known for a number of years by growers of cotton on the Lower Shire that cotton bursting in the period September to October is almost invariably of good quality, but this is the first time that it has been possible to make observations on a station under the Corporation.

What the control is which affects the various insect pests it is at present difficult to say, but it seems probable that it is some climatic agency. The interesting point, therefore, arises whether by means of suitable methods of cultivation there is a possibility of being able to "dodge the pests."

The conditions making it possible to grow cotton as a dry-weather crop on the Lower Shire appear to be as follows: A mean minimum temperature which never drops below 60° F., the presence of abundant subsoil moisture in the alluvial soils which are cultivated, and the frequent occurrence of light rains during the period June to August, which probably assist the cotton mainly by keeping atmospheric humidity at a high level, and so keeping down the water strain.

It is interesting to note that there seems to be an end to this

“close season” for cotton pests somewhere about the middle to end of October, since on October 18, at Chikwawa, not only was very late-planted cotton infested with young Red Bollworm larvæ, but fourteen moths were caught at a light on the evening of that day, the catch consisting of eight females and six males. Numerous hatchings of stainer nymphs were also observed on this cotton.

It is interesting to note that the insistence of the Lower Shire native on close spacing, even though his cotton is grown under conditions of drought, may be due to his desire to force the cotton on to maturity in order to avoid this recrudescence of pest attack.

EXTENSION OF THE PORT HERALD COTTON STATION.

In view of this season's experience, it was considered advisable to extend both the area under cultivation and the scope of the work at this station during the coming season.

Liwonde was closed down as soon as harvesting was complete and handed over to the District Resident on the understanding that, should it be again required in the future, no difficulty would be made in regard to its reacquisition, while arrangements were made to enlarge Port Herald. Approximately 15 acres more were cleared from the bush and about 5 acres of native gardens which had been newly cleared were taken over, their owners being compensated, and a rectangular block of 30 acres so formed.

This area is being laid out in twelve fields of 2.5 acres, each divided into two main cultivation areas by a narrow buildings block of about 1 acre. It had been originally intended to erect a small rest-house and store at each of the sub-stations, but with the change of plans it was decided to concentrate on a serviceable farm building on the lines of those built at Makwapala. A building in the form of a hollow square has been designed and is at present in the course of erection. This will comprise stores, stalls for three pairs of cattle, and a farm office.

Native labour lines are also being laid out on the buildings block, and a well is being sunk which will serve as a source of water both for these lines and for the working cattle. This is necessary, since the River Shire is over a mile distant.

As regards housing for the European officer in charge of the station, it was found that a house, formerly occupied by the medical officer stationed at Port Herald, was available within easy reach of the station, and on being approached Government not only agreed to allot this house to the Corporation's use, but allocated a sum of money towards its renovation and supplied furniture. In addition

to having access to a good water supply and being in a fair state of repair, this house has the additional advantage of possessing an out-building which is admirably suited to use as a laboratory.

For the 1926-27 season, therefore, there will be a station at Port Herald, situated in the heart of what is at present the chief cotton-producing area of the country, on half the scale of Makwapala.

COTTONS AT MAKWAPALA AND THE SUB-STATIONS.

“*Over the Top.*”—As described under “Rotations at Makwapala,” “Liwonde,” and “Port Herald,” a strain of an American Upland known as “Over the Top,” and designated as strain “B,” has been grown this season in a number of increase plots with a view to obtaining a seed stock for extended trial in the coming season. This cotton has so far proved the healthiest, and apparently the most prolific, cotton grown at Makwapala of any strain, imported or otherwise, and it has this season maintained these qualities at all three stations. In the three years in which it has been grown in Nyasaland it has proved practically immune to the attack of Jassid.

Samples of this cotton have this season been obtained from all three stations, and experimental ginnings have been made by the B.C.G.A. The average ginning percentage is about 31 per cent., whereas Nyasaland Upland does not average more than 30 per cent., and is often less; the staple length is little, if any, inferior to that of much of the Nyasaland Upland in cultivation. Samples of the lint from the experimental ginnings have been sent to England for examination and trial, together with samples from the Port Herald native grown crop, which are representative of the main bulk of Nyasaland Upland seed now being grown.

Arrangements are being made to grow this strain in a series of spacing and time of planting tests at Makwapala and Port Herald during the coming season, and to conduct a variety trial at both stations with this cotton and Nyasaland Upland. In addition, by the courtesy of various estates, seed will be distributed in quantities each sufficient for one 5-acre plot with a view to obtaining a “commercial test” of the strain. These test-distribution plots will also act as increase plots for multiplying the seed stocks at present available.

Cottons in the Breeding Plot.—All cottons now being grown other than the “Over the Top” mentioned above are still in the breeding plot.

In this plot the main endeavour is to produce unit strains of the more promising varieties, and to grow increase blocks of these strains,

which shall provide seed for field scale tests of the strains against established varieties and for further multiplication and distribution if found to be of value.

From the large number of single plant selections made from the "Over the Top," strain B in the 1924-25 season some dozen sub-strains are being carried on to next season. In addition to these, several sub-strains have been obtained from the original importation of "Over the Top," strain A, and from a particularly prolific and even ripening variety of Trice, to which the "Over the Top" is related.

With the exception of a promising strain from the Lower Shire, none of the numerous Nyasaland Upland strains selected have survived the past two seasons.

Among the long staples imported, only a number of sub-strains from a Foster-Whitehall cross, obtained from the Mississippi, have survived. Unfortunately, owing to the absence of the cotton specialist from Nyasaland during August, it was not found possible to complete the figures in connection with the cottons in the breeding plot in time for their inclusion in this report, but the whole range of figures covering the lint and seed characteristics of the cottons to be carried on to next season will be given in next year's report.

In the coming season all the cotton selection and breeding work will be duplicated at Makwapala and Port Herald. In addition to the fuller information which will be obtained, it is hoped that this duplication will ensure that, whatever the season may be, sound seed stocks will always be available for sowing in the following year and that this season's difficulties in regard to bad seed will be avoided.

The differences in climate and in mode of cultivation between the two stations is such that a wet season, which is a disadvantage at Makwapala, helps Port Herald by augmenting the supply of subsoil moisture, and as far as records go the converse is true, a dry year meaning less bollworm at Makwapala.

CONTINUOUS RECORDS.

A commencement has been made this season in keeping continuous records on the lines laid down by Dr. W. L. Balls.

In addition to the study in the usual way of environmental factors in their relations to the development of cotton, the scope of these records is being extended to cover the incidence and intensity of the various insect attacks, which are the main obstacle to the successful production of cotton in Nyasaland.

During the year a small nucleus staff of native observers was

collected, and a start was made at Makwapala by recording factors affecting a number of plants marked in fields 4 and 8. It was unfortunate that the observations could not be carried out on a properly arranged series of plots, but this will be remedied in the coming season, when it is intended to carry out a variety trial at both Makwapala and Port Herald. Incidentally it is hoped to extend the scope of the records considerably. The records which it has so far been possible to keep are as follows:

Growth of stem (measured weekly).

Flowers (counted daily).

Bollworm losses (infested material picked daily, and counted).

Bolls (picked bi-weekly, and counted).

Rainfall (daily measurements).

Temperatures (maxima and minima daily).

A thermohygrograph was secured, but unfortunately developed defects. The graphs obtained (Appendix III.) give a very fair idea of the seasonal history of the strains, except that the severe Jassid infestation of strain G is not demonstrated, owing to the observation plants having been on a part of the field which was relatively free from this pest.

It was not expected, of course, that this season's observations would do much more than afford training and experience to the observers, but it has resulted in several interesting notes and guides to future work. It was observed that, under the conditions of severe bollworm attack prevailing at Makwapala this year, no physiological shedding occurred, all losses being attributable to bollworm. The daily pickings of infested bolls are records of the bollworms hatching out daily, and are probably a record of the egg-laying, with, of course, a lag, due to the time taken for the eggs to hatch.

It is intended in the coming season to analyze the daily pickings of infested material into squares, flowers, and bolls, and in addition to make periodic analyses of the bollworm population of the field in order to assess the damage done by the various species. It seems highly possible that the most important bollworm this season was the American Bollworm (*Chloridea obsoleta*), rather than the Red Bollworm (*Diparopsis castanea*).

There were indications, when considering the graphs and their relation to the yields obtained from the various fields, that the method whereby it has been attempted to control the bollworms by stripping and destroying the first flush of flower buds and squares, and so destroying the first brood, must be viewed with suspicion, since by so doing the crop is made later and the flowering and fruiting is forced into the period of maximum bollworm activity in April.

It seems evident that, by the aid of such sets of records, when extended to embrace as many as possible of the factors affecting the crop, it will be possible to make analyses of the relationships between the environment, including the pests, and the development of the several varieties of cotton on a very exact basis. If it is confirmed that the incidence of the pests is to a large extent seasonal, as is suspected at present, it should be possible by the aid of these records to devise ways of evading the pests sufficiently to ensure a good crop.

Catching Bollworm Moths in the Field.—Acting on a suggestion made by Mr. King, the E.C.G.C. entomologist in Nyasaland, a small reward was offered for all Red Bollworm moths caught in the field and brought to the farm manager. This offer met with the approval of the native labour, and the monthly catches of *Diparopsis castanea* made are given below; the numbers represent moths of both sexes: January, 3; February, 299; March, 249; April, 28; May, 5.

The effects of this destruction were, as far as could be seen, nil, and it is not possible to analyze the factors nullifying the result. It is probable that many moths went uncaught, and it is certain that the American Bollworm had a lot to do with the lack of results. A considerable number of American Bollworm moths were caught, but not recorded, since their importance was not recognized at the time.

It is intended this next season to give this method a very much more determined trial, and to offer and pay rewards for all moths which are brought in. Periodic analyses of the catches will be made.

Delinting of Cotton Seed with Concentrated Sulphuric Acid.—The beneficial effects obtained last season by treating with concentrated sulphuric acid all cotton seed from outside sources have been described above (p. 175). It appeared altogether that with sound seed this method had a considerable number of advantages.

In the current season, however, a large proportion of the seed which had to be used for sowing was from stained cotton, and the sulphuric acid treatment did not give the same results as those obtained last year.

The impression was gained that, though sound seed did not appear to be affected by the treatment, what may be described as "border-line" seed, which, if not treated, germinated quite well, was killed by the acid.

It was considered unsafe to do more with this method of seed treatment until an analysis had been made into the technique and the effects on the seed. Arrangements are therefore being made to have a sample of seed of known history sent to a properly equipped laboratory in England, where portions may be subjected to various strengths of acid and for various times of exposure to the acid.

Selfing.—Since the method of selfing (ensuring self-fertilization) the flowers of cottons in the breeding plot, by sewing up the individual flowers before their opening, had not been made to work satisfactorily under Nyasaland conditions, while in addition the predilection of the various bollworms for the newly opened flowers was disadvantageous to either the tying or sewing methods of selfing, it became necessary to devise a method which should be free from such disadvantages.

Bagging the flowers with small bags made of sand-fly mesh mosquito netting was tried, and found to work satisfactorily, but difficulty was found in making the bags cheaply enough. In addition, once tied in position, they were by no means easy to take off again quickly without damage.

A method was therefore devised whereby, instead of a bag, a small square of netting was used, placed over the flower, and held in position by a small rubber ring.

This had the advantage of being both easy to place in position and to remove, and effectually prevented the entry of insects to the flower. The size of square used was 8×8 inches.

During the coming season it is intended to use this method on a considerable scale. By dyeing sets of the squares two or more colours it will be possible to ensure the gauze being left in position for as many days after flowering as there are colours. Flowers which are successfully selfed will be marked by tying a small piece of coloured material to the petiole.

Each piece of gauze may be used a considerable number of times; five months' exposure this season to all weathers has had no appreciable effect on the gauze tested as regards deterioration.

Anti-Soil Erosion Measures at Makwapala.—One of the main difficulties of cultivation at this station is the washing away of the soil during the very heavy showers of which the main rains chiefly consist. Rain falling at the rate of 4 to 6 inches per hour is by no means uncommon, and the most porous soil is unable to absorb all the water when applied at this rate. The problem therefore arises of preventing the flow of surface water during the rains from doing damage.

As mentioned elsewhere, a contour survey has been made of the whole cultivation area and of the buildings block, and the contour lines at 3 feet vertical distances have been accurately mapped.

Three methods of checking wash are being put into operation. The first is a suggestion from Mr. Davy, the Assistant Director of Agriculture, and consists in planting narrow strips of Msengere grass along the contours mentioned above. It is hoped to have fields 1

to 4 planted up with these strips during the coming season, and in addition to plant up all the lower sides of these fields with strips, thus completing the trial plantings made this present season. Msengere grass is the Napier fodder grass of Southern Rhodesia. It is a perennial grass of tufted habit which seldom if ever sets seed, and there is little risk of its becoming a weed. In addition, it is a valuable cattle fodder which provides green food at a time when all else is dried up and unpalatable. It is hoped that these strips will slow down surface wash and so prevent erosion. The experimental plantings made this season certainly indicate that this will be so.

The second method is that of level ridge terraces, and is being employed in fields 10, 11, 12, and 5.

The preliminary ridges have already been made. It is hoped in a few years to build these up into large ridges about 12 feet wide at the base and 3 feet in height. Since they are laid out on the 3-foot contours, this means that the top of one will be on a level with the base of the one above. The principle, which has been found successful in other countries, is that of slowing down the flow of surface water to a rate below that at which it acts as an erosive agent. No obstacle is offered by these ridges to cultivation.

The third method is that of contour drains at small falls within the drain itself laid out on the 3-foot contours and discharging into main drains at the field sides. This is being applied to fields 6, 7, 8, and 9, and to the buildings block. This method has been found successful on one estate in Nyasaland on far greater slopes than that at Makwapala, and there is little doubt of its proving successful. A continuous line of Mtutu (*Tephrosia vogelli*) will be drilled on either side of the drains to prevent their sides either caving in or being trodden in by the bullocks when ploughing.

In addition to draining the buildings block, it is proposed to plant up the areas round the rest-house and the farm-manager's house with "dub" grass, an excellent agent for checking soil erosion, and also to plant a considerable number of flowering, shade and fruit trees, and bamboos, all of which will assist in preventing wash.

Staff during the Year.—Mr. H. C. Sampson left for England on December 7, Mr. H. C. Ducker, who returned from leave on December 2, taking over the duties of Cotton Specialist. Mr. W. L. Miller was stationed at Makwapala throughout the year as farm manager. Mr. T. McEwen had charge of the sub-stations up to his departure on leave on May 20, when Mr. E. Lawrence took charge of the Port Herald Station and the extension work and building at this station.

APPENDIX I

DAILY RAINFALL IN INCHES AT MAKWAPALA,
SEASON 1924-25.

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	—	—	—	0.02	—	0.09	0.01	—	—	—	—	—
2	—	—	0.79	0.13	—	0.50	—	—	—	—	—	—
3	—	—	0.14	0.84	—	0.15	—	—	—	—	—	0.28
4	—	—	1.87	0.04	—	—	—	—	—	—	—	0.04
5	—	—	1.22	1.85	—	—	—	—	—	—	—	—
6	—	0.26	0.31	0.17	—	0.62	—	—	—	—	—	—
7	—	0.18	—	1.40	0.05	0.02	0.04	—	—	—	—	—
8	0.10	—	—	0.43	0.03	0.21	—	—	0.06	—	—	—
9	—	—	0.13	0.06	0.50	—	0.02	—	—	—	—	—
10	—	—	1.28	0.64	0.10	0.24	0.18	—	—	—	—	—
11	—	—	0.14	0.16	1.23	0.03	0.05	—	—	—	—	—
12	—	—	1.02	0.03	0.70	0.02	—	—	—	—	—	—
13	—	0.14	0.20	2.15	0.83	—	—	—	—	—	—	—
14	—	—	0.30	—	0.35	—	—	—	—	—	—	—
15	—	0.13	1.22	—	0.22	—	—	—	—	—	—	—
16	—	0.90	0.08	1.46	—	—	0.21	—	—	—	—	—
17	—	1.16	0.48	0.26	0.03	—	0.04	—	0.12	—	—	—
18	—	0.28	—	0.38	0.98	—	—	—	—	—	—	—
19	—	0.14	—	0.54	—	—	—	—	0.06	—	—	—
20	—	—	—	0.22	0.03	—	—	—	—	—	—	—
21	—	—	0.69	—	0.52	—	—	—	—	—	—	—
22	—	—	0.01	0.09	0.41	0.03	—	—	—	—	—	—
23	—	—	0.62	0.37	—	—	—	—	—	—	—	—
24	—	—	0.03	0.10	—	—	—	—	—	—	—	1.22
25	—	—	0.05	0.05	0.01	—	—	—	—	—	1.00	—
26	—	0.05	—	0.02	0.01	0.26	—	—	—	—	—	—
27	—	0.31	0.15	0.05	0.05	0.06	—	—	—	—	—	—
28	—	—	0.41	0.05	0.01	0.08	—	—	—	—	—	—
29	—	0.28	0.20	—	0.28	—	—	—	—	—	—	—
30	0.09	0.10	0.30	—	0.01	—	—	—	—	—	—	—
31	—	0.60	0.14	—	0.47	—	—	—	—	—	—	—
Total	0.19	4.53	11.78	11.51	6.82	2.31	0.55	—	0.24	—	1.00	1.54

Total rainfall for season, 40.47 inches.

DAILY RAINFALL IN INCHES AT MAKWAPALA,
SEASON 1925-26.

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	—	1.07	—	—	0.54	0.66	—	—	—	—	—	—
2	—	—	—	—	0.28	0.02	—	—	0.12	—	—	—
3	—	—	—	0.11	—	—	—	—	—	—	—	—
4	—	—	0.40	0.89	1.52	—	—	—	—	—	—	—
5	—	—	—	0.34	—	—	—	—	—	—	—	—
6	—	—	—	2.20	2.22	—	—	—	—	—	—	—
7	—	—	—	0.04	—	—	—	—	—	—	—	—
8	—	—	0.16	—	0.66	—	—	—	—	—	—	—
9	0.68	0.14	—	0.08	—	—	—	—	—	0.02	—	—
10	—	—	1.43	0.25	0.75	—	—	—	—	—	—	—
11	0.28	0.34	0.52	0.02	0.12	—	—	—	—	—	—	—
12	—	0.26	1.26	2.27	—	0.19	—	—	—	—	—	—
13	—	—	0.36	—	—	0.09	0.05	—	0.05	—	—	—
14	—	—	1.36	—	—	—	—	0.07	—	—	—	—
15	—	0.63	1.30	—	—	—	—	—	—	—	—	—
16	—	0.20	0.68	—	0.21	—	—	—	—	—	—	—
17	0.22	0.07	0.40	—	2.45	—	—	—	—	—	—	—
18	—	1.05	1.09	—	0.06	—	—	—	—	—	—	—
19	—	0.16	0.11	0.08	—	—	—	—	—	—	—	—
20	—	—	0.50	—	0.14	—	0.06	—	—	—	—	—
21	—	—	—	1.46	0.25	0.10	—	—	—	—	—	—
22	—	—	2.13	0.13	0.06	—	—	—	—	—	—	—
23	—	—	2.57	1.23	—	0.07	—	—	—	—	—	—
24	—	—	0.08	—	—	—	—	—	—	—	—	—
25	0.36	0.68	2.07	—	1.61	0.04	—	—	0.09	—	—	—
26	—	—	1.58	1.00	0.03	—	—	—	0.01	—	—	—
27	—	0.03	2.81	0.30	—	—	—	—	—	0.04	—	—
28	—	—	2.04	—	0.15	—	—	—	—	—	—	—
29	1.54	—	0.63	—	—	—	—	—	—	—	—	—
30	3.19	—	—	—	—	—	—	—	—	—	—	—
31	—	0.68	0.69	—	0.36	—	—	—	—	—	—	—
Total	6.27	5.31	24.17	10.40	11.41	1.17	0.11	0.07	0.27	0.06	—	—

Total rainfall for season to September 30, 59.24 inches.

DAILY RAINFALL IN INCHES AT PORT HERALD,
SEASON 1924-25.

	<i>Nov.</i>	<i>Dec.</i>	<i>Jan.</i>	<i>Feb.</i>	<i>Mar.</i>	<i>Apr.</i>	<i>May.</i>	<i>June.</i>	<i>July.</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>
1	—	—	0·13	0·69	—	0·16	—	—	—	—	—	—
2	—	—	0·85	—	—	0·30	—	—	—	—	0·25	—
3	—	—	—	0·54	—	—	—	—	—	—	—	—
4	—	—	0·26	—	—	—	—	—	—	—	—	—
5	—	—	1·94	0·25	0·46	0·07	—	—	—	—	—	—
6	—	—	0·19	0·03	—	0·29	—	—	—	—	—	—
7	0·12	1·15	0·20	—	—	0·41	—	—	—	—	—	—
8	—	—	0·30	0·22	0·45	—	—	—	—	—	—	—
9	1·90	—	1·48	0·12	—	—	—	—	—	—	—	—
10	0·18	0·17	—	0·18	0·43	—	0·10	—	—	—	—	—
11	—	—	0·65	—	0·14	—	—	—	—	—	—	—
12	—	—	0·70	0·22	—	—	—	—	—	—	—	—
13	—	—	0·17	—	0·74	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	0·38	—	1·12	—	—	—	—	—	—	—
16	—	0·36	5·59	—	—	—	—	—	—	—	1·40	—
17	—	—	0·77	0·25	—	—	—	—	0·18	—	—	—
18	—	—	—	—	0·50	—	—	—	—	—	—	—
19	—	0·02	—	—	—	—	—	—	0·40	—	—	—
20	0·37	—	—	0·50	—	0·49	—	—	—	—	—	—
21	—	0·53	0·41	—	—	—	—	—	—	—	—	—
22	—	—	0·27	0·11	0·48	—	—	—	—	—	—	—
23	0·75	1·94	0·58	—	—	0·24	—	—	—	—	0·30	0·94
24	—	—	—	1·29	—	—	—	—	—	—	0·30	—
25	—	—	2·22	0·13	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	0·36	—	—	—	—	—	—
28	0·10	0·86	0·22	—	—	—	—	0·16	—	—	—	—
29	—	—	—	—	—	—	—	0·18	—	—	—	—
30	0·22	5·40	0·10	—	0·58	—	—	0·18	—	0·19	—	—
31	—	1·34	—	—	—	—	—	—	—	—	—	—
Total	3·64	11·77	17·41	4·53	4·90	2·32	0·10	0·52	0·58	0·19	2·25	0·94

Total rainfall for the season, 49·15 inches.

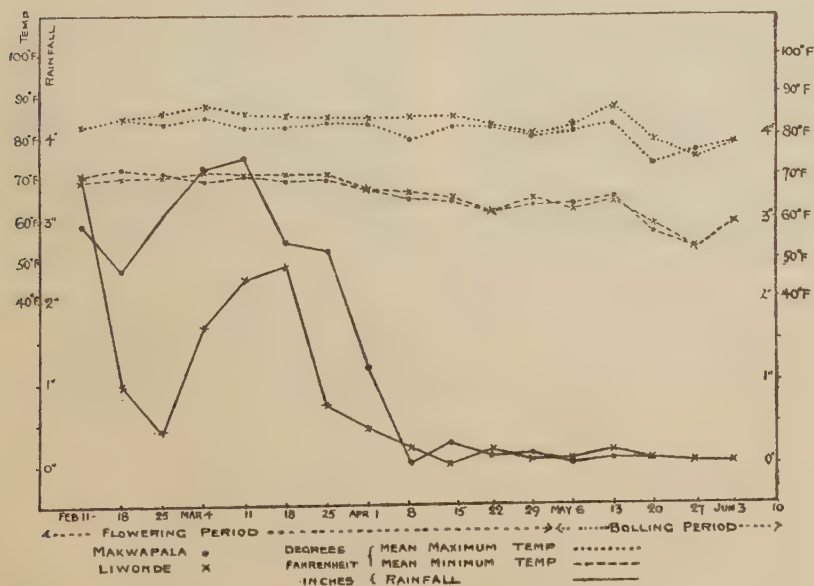
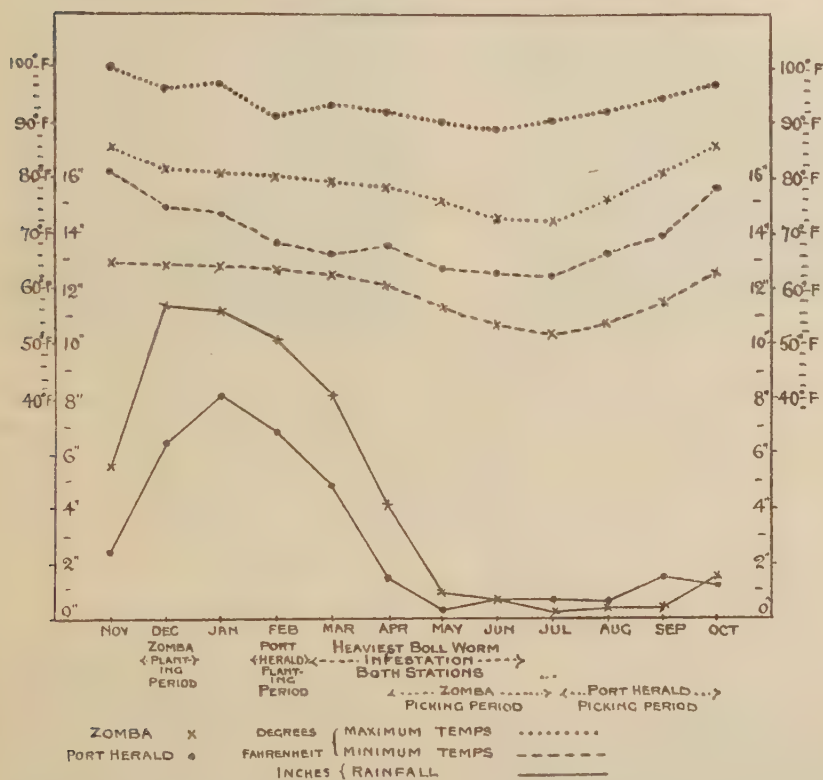
DAILY RAINFALL IN INCHES AT PORT HERALD,
SEASON 1925-26.

	<i>Nov.</i>	<i>Dec.</i>	<i>Jan.</i>	<i>Feb.</i>	<i>Mar.</i>	<i>Apr.</i>	<i>May.</i>	<i>June.</i>	<i>July.</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>
1	—	—	—	—	3.50	—	—	—	—	—	—	—
2	—	—	—	—	0.48	0.60	—	—	—	—	—	—
3	—	—	—	0.65	—	—	—	—	—	—	—	—
4	0.46	—	1.0	0.60	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	0.90	—	—	—	—	—	—	—	—	—	—	—
7	—	—	0.20	0.98	—	—	—	—	—	0.03	—	—
8	—	—	0.22	—	—	—	—	—	—	—	—	—
9	—	0.97	—	0.84	1.16	—	—	—	—	0.20	—	—
10	—	—	2.70	—	5.38	—	—	—	—	0.08	—	—
11	—	—	0.80	—	0.36	0.07	—	—	—	—	—	—
12	—	0.08	—	—	—	0.10	—	—	—	—	—	—
13	—	—	0.11	—	0.20	—	—	—	—	—	—	—
14	—	—	2.00	—	—	—	—	—	—	—	—	—
15	—	—	0.17	—	—	—	—	—	—	—	—	—
16	—	0.48	—	—	—	—	—	0.39	—	—	—	—
17	—	—	0.60	0.19	—	—	—	—	—	0.10	—	—
18	—	1.58	2.42	—	—	—	—	—	—	—	—	—
19	—	—	0.50	—	—	—	—	—	—	—	—	—
20	—	—	1.24	—	—	—	—	—	—	—	—	—
21	—	—	—	—	0.20	0.40	—	—	—	—	—	—
22	—	—	0.65	—	0.15	—	—	0.08	—	—	—	—
23	—	—	—	—	—	0.52	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	0.20	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	0.15	—	—
29	0.09	0.93	—	—	—	—	—	—	—	—	0.06	—
30	1.15	—	0.90	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—
Total	2.60	4.04	13.51	3.26	11.43	1.69	—	0.47	0.20	0.56	0.06	—

Total rainfall for season to September 30, 37.82 inches.

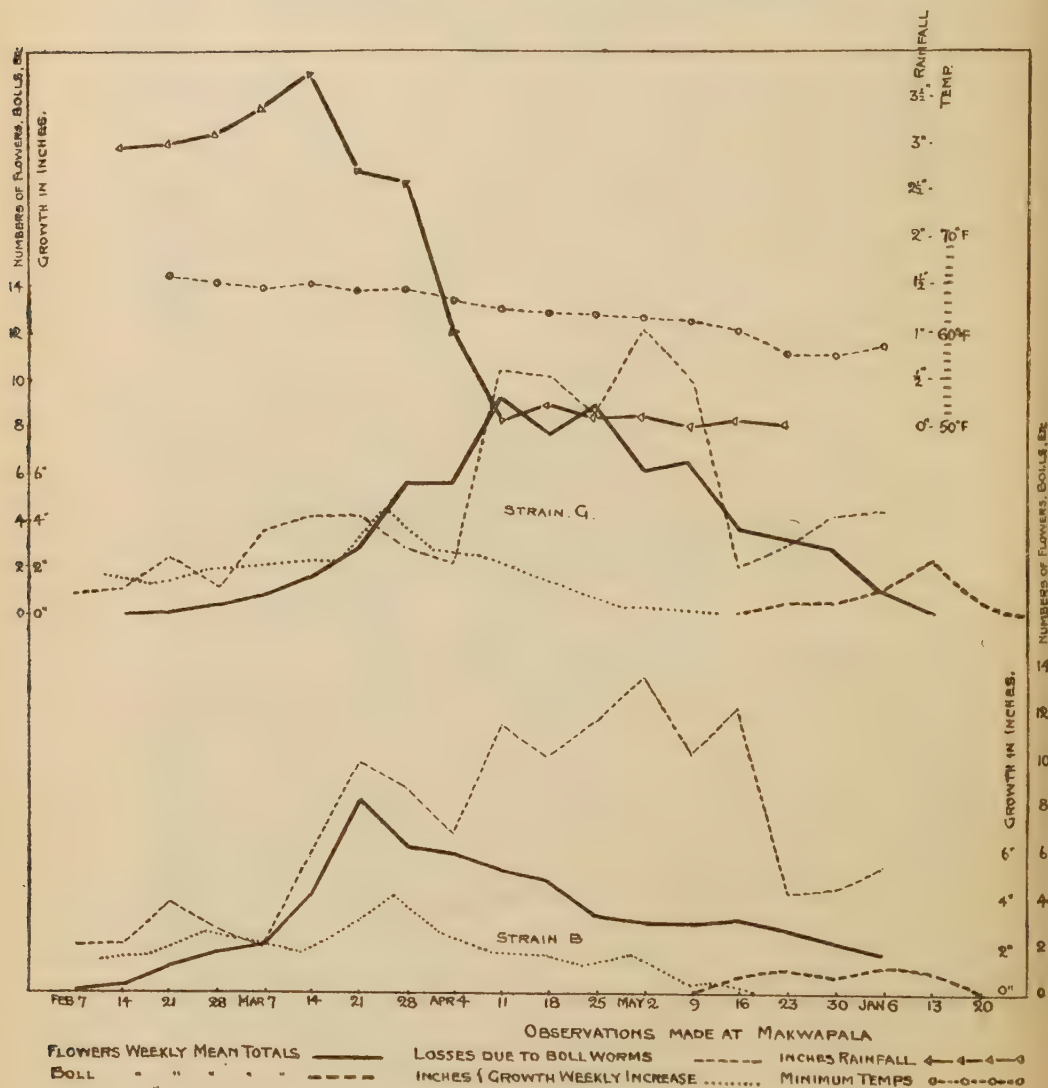
APPENDIX II

TEMPERATURE AND RAINFALL CURVES AT MAKWAPALA AND LIWONDE FOR THE SEASON 1925-26; THOSE FOR ZOMBA AND PORT HERALD ARE AVERAGES OVER THE PAST 5 YEARS.



APPENDIX III

PLANT DEVELOPMENT CURVES (PAGE 191).





PLANT OF "OVER THE TOP," FROM FIRST
IMPORTATION.



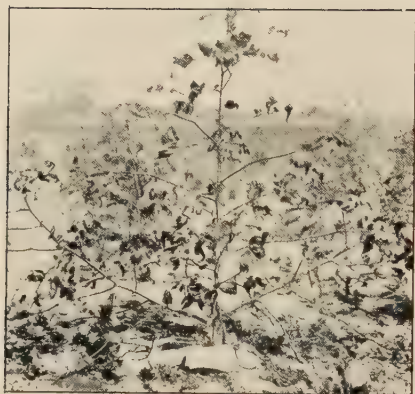
PLANT OF "OVER THE TOP," FROM
SECOND IMPORTATION.



"NYASALAND UPLAND," GOOD TYPE OF
PLANT—FIELD 9.



PLANT OF PROLIFIC VARIETY OF "TRICE"
—FIELD 12.



"FOSTER-WHITEHALL," JASSID
SUSCEPTIBLE TYPE.



"FOSTER-WHITEHALL," JASSID RESISTANT
TYPE—FIELD 9.



AN EARLY PLOUGH FALLOW GROUND,
PLOUGHED IN APRIL AFTER BULRUSH
MILLET HAS BEEN REMOVED AND STOOKED.



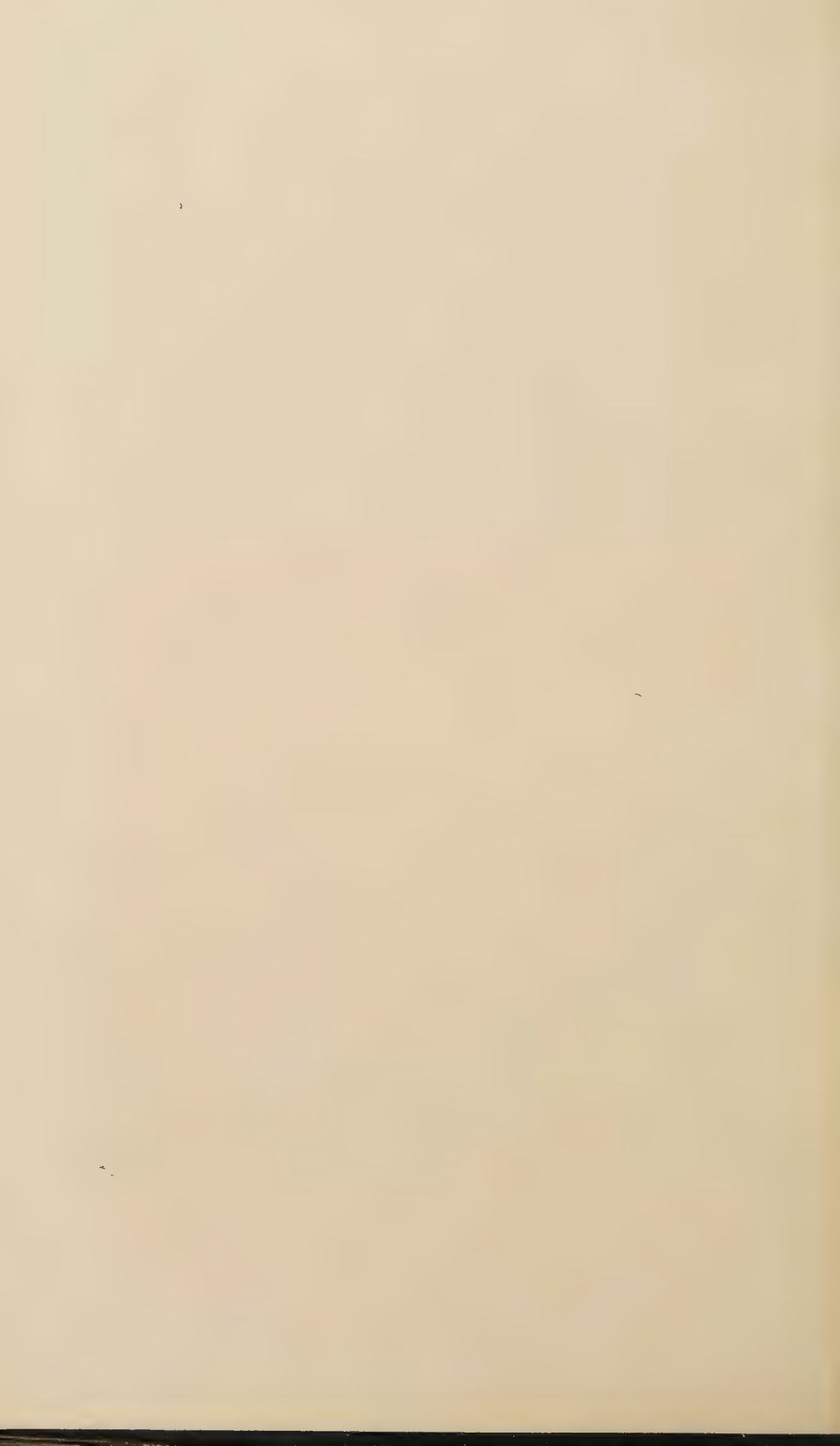
SUNNHEMP GROWN AS A ROTATION CROP.



SOIL EROSION IN COTTON FIELD—FIELD 8.



NAPIER FODDER GRASS PLANTED TO CHECK SOIL EROSION.



NIGERIA

REPORT ON THE ESTABLISHMENT OF THE EMPIRE COTTON GROWING CORPORATION'S FIRST SEED FARM IN NORTHERN NIGERIA

BY

J. DAWSON SHEPHERD, O.B.E.

THE site of the Seed Farm is at Daudawa, about sixty miles from Zaria on the motor road from Zaria to Sokoto. This site had been chosen by Mr. Faulkner, the Director of Agriculture, from a number of sites suggested by Mr. Barry Browne, one of the Superintendents of Agriculture, Northern Provinces. The Farm runs along a base line of two miles parallel to the road and separated from it by a belt of bush land from 30 to 350 yards wide. The perpendicular to the base runs roughly north and south, and is a mile long. The whole area, therefore, is a parallelogram of 1,280 acres. The area between the Farm and the road is 157·2 acres. The site for Staff houses and any future buildings is on a ridge on the south side of the motor road. After clearing the bush, a wide view of the surrounding country will be obtained, and, standing as it does about 2,500 feet above sea level, well away from swamp land, it should prove very healthy. An area of about 60 acres has been reserved here.

I take this opportunity of expressing my most grateful thanks to the Officials of the Department of Agriculture for their unfailing readiness to satisfy my thirst for information and to give most valuable advice.

The Emir of Katsina is much interested in the Farm, and has paid several visits during the summer.

Early in January quarters were established at the Rest Camp near Daudawa Village. The preliminary work of arranging with the local Headman for labour, making a rough survey of the ground, fixing a site for the first Staff House and clearing a road to it, and obtaining a general idea of the surrounding country occupied us until nearly the end of January. On the 18th a flying visit was paid us by Colonel French. His advice regarding the making of a motor road to the house after the Uganda system was followed. The road is a complete success, and has cost 10d. a yard run in place of the 2s. it would have cost otherwise.

Previous to our arrival, a Hausa Surveyor had made a rough plan of the Farm, and in doing so had made several false drives through the "bush." We obtained from the Native Administration the services of this man, who picked up our requirements very quickly and was occupied for a month with a gang of men in cutting the bush, by means of drives through it at right angles to the base line, into sections of 80 acres, each a mile long by 220 yards broad. In these drives pegs were driven every 22 yards, thus marking the 80-acre section into acres. In this way, when the work of clearing was started, it was possible to know at any moment how the work was progressing and almost the exact cost.

Bush Clearing.—The "bush" in the Daudawa area is denser than the general run of "Savanah" or orchard bush. A timber content of 220 tons is estimated to the acre, and trees range from saplings to giants as much as 10 feet in circumference. The average tree, however, is about 3 to 4 feet. At first, block and tackle were used for hauling down the trees after the lateral roots had been cut to a depth of 18 to 24 inches below the surface of the ground. It was soon found that half a dozen men at the end of a rope, fastened as high up the tree as possible, was as effective as and much quicker than the more scientific method. The men were divided into three gangs of varying number. No. 1 gang, armed with hoes, cleared away the earth from the lateral roots; No. 2 followed with axes, cutting the roots and sometimes weakening the main root; and No. 3, a composite gang, succeeded the 2nd—sometimes too quickly—equipped with rope, axe, and hoe, and pulled down the trees. An extra gang was employed cutting the larger trunks into handy lengths, piling these along with brushwood into heaps and burning them. Since it was too wet to allow of rapid burning, and there was no time to wait for the heaps to dry, on 40 acres, all the wood was carried to the side of the 10-acre blocks and stacked there ready for burning in the dry season. This increased the cost of the work by about 25 per cent. A block of 10 acres was finished at a time, and took between twelve and fifteen days. The cost per acre was always averaged over the 10-acre block, but at any time one could see whether the cost was going beyond reason or not. The minimum over a block was 22s. per acre and the maximum 40s. This maximum, besides being due to heavier timber, was attributable to the transport of the wood over distances up to 220 yards. To date, the total average cost works out at about 32s. per acre. This will fall in the dry season. In all, 150 acres have been cleared and stumped ready for cultivation. An additional area of about 40 acres, including the

residential site, has been cut and burnt, but not stumped completely.

A great number of lateral root ends are left in the ground. This is unavoidable, but, fortunately, their presence is soon betrayed by the luxuriant shoots they send up immediately after the rains start. Their removal goes on throughout the whole of the first cultivating season and adds considerably to the cost of cultivation.

Breaking Ground.—It was thought that with the time at our disposal an area of 60 or 70 acres might be ready for cultivation before the rainy season was well advanced. It would have been impossible to achieve even this area if breaking had been left until the ground had been softened by the early rains. By the end of March, therefore, a start was made on the first 10-acre block. Had our tools from England been available we should have started even earlier. The soil has a fair proportion of sand and laterite gravel in it, and the wear on the hoes was very heavy. The ideal time for this breaking is June, when the land has been well softened and the grass is not too high. In July and August it costs as much as in April, owing to the necessity of clearing away the tangle of grass and weeds, which in places was 2 to 4 feet high. An interesting feature of this work was the increase in output when the men worked to drum playing. From a musical point of view it was interesting also to note the different drum songs. Many of these were as popular and rousing with the Hausa as "John Brown's Body" is with us. I have seen as many as fifty hoes rising and falling to the beat of the drum with the precision of a regiment on the march. A good drummer will spot a slacker, and, getting in front of him, will play to him alone, thus inspiring him to greater effort.

On the land, afterwards sown to cotton in the beginning of July, the minimum cost of breaking an acre was 17s. 6d. and the maximum 36s. Since our supply of labour was good, it was decided to clear as much ground and cultivate as much as possible before the finish of the sowing season—viz., the beginning of September. By the last week in July, however, having exhausted our bean seed supply and finished twelve 10-acre blocks, we called a halt in cultivation. With the lay-out of the land any further cultivation would have broken into a new area separated from the first 120 acres by fire and wind breaks.

Cotton.—With the object of weathering the soil, every cotton plot of 10 acres was ridged up as soon as it was broken. As the last 10 acres had to be sown immediately after the ridging it was sown on very shallow ridges indeed. Ridges are made by an implement called a "galma." It is similar to those depicted in Egyptian tomb

pictures dating thousands of years before Christ. From it has evidently been evolved the exceedingly useful and satisfactory ox plough still in use throughout the East.

The depth from furrow to ridge top recommended locally is 18 inches, with ridges 4 feet apart. Had ridging been made to this depth, unaerated soil would have been the growing medium, so ridges were made about a foot high from soil turned to a depth of 4 to 5 inches. A bar, or cross bridge, was made every 10 yards to prevent scouring in the heavy rains. The necessity for bars so close together was not apparent, but it is too early to criticize or to attempt any radical change in cultivation methods. With the exception of the wider ridges, the cotton was treated more or less on Egyptian lines; but much less seed was sown to the acre, and the thinning might have been carried out sooner. Thinning is not very general with the natives, and when it is done, is done very late. Similarly, their first hoeing seems to be too late. At present the vast number do not cultivate their crops; they merely grow them. Apart from other considerations, the usefulness as demonstration centres of a number of seed farms scattered throughout the cotton districts is apparent. Cultivation at Daudawa from the middle of September to the end of October is being confined to following methods of conserving moisture, but one or two experiments will be made. With labour at 9d. a day, and with straightforward cultivation I put the cost of a crop at £2 10s. per acre, and think it might be done for less. A few leaf worms, some aphids, and a little leaf curl are the pests noted to date, and all are so far minor. The general appearance of the cotton, while irregular—as is to be expected on new ground—is good. By the second week in September—*i.e.*, ten weeks from sowing—the number of flowers to a stand (two sticks) averaged, except on resown cotton, about ten. The luxuriance of cotton on and about ant-hills surpasses anything I have seen anywhere. It demonstrates possibilities for the crop which are causing me to exchange the somewhat unfavourable impression I formed of the situation when I first arrived in the country for one of cautious optimism.

Other Crops.—The 120 acres cultivated were intended for division equally between cotton, cereals, and leguminous crops. The proportions had to be altered, however, and beans have been sown in a plot originally sown to guinea corn. An attempt was made to sow beans in all the corn, but good seed was not forthcoming in time. A plot marked down for corn was sown in beans, and 10 acres of ground nuts were planted. In half of this 10-acre plot germination was very bad, but with this exception one might say safely that the whole area has

responded well to the first year's cultivation; in fact, much better than was expected, and I consider the choice of land a very happy one.

To sum up this section of my report, the crops actually sown are: 40 acres cotton, 20 acres guinea corn, 10 acres ground nuts, 50 acres beans, of which ten will be allowed to seed and the remainder ploughed in. Granted a normal season, the cotton will yield a crop above the native average, the guinea corn 75 per cent. or a little less than the average, and the beans average. The ground nuts seem likely to prove the best crop on the farm.

Since cultivation of new ground was stopped in August, 30 acres have been cleared ready for cultivation. It is hoped to clear another 70 acres before the end of December, by which time the first farm should be in full running order and equipped with the necessary buildings and dwellings for Staff and labour.

Buildings, Villages, and Water Supply.—Not only is skilled agricultural labour difficult to obtain (for example, our foremen are an old cook and a Company-Sergeant-Major), but masons are almost impossible to find. The agricultural station at Samuru sent me a worthy old gentleman, and a better man turned up by chance. Before either appeared, a start had been made in teaching some of the brighter labourers the elements of building. These lads have responded really remarkably well. Our medium is laterite blocks dug from the surface of the ground and roughly shaped, and mud used as mortar. The walls, 18 inches thick, are pointed with a mixture of 1 to 7 or 8, cement and sand. Largely because the majority of the masons are not yet getting masons' pay, the price per cubic metre is reasonably cheap, and works out about 12s. A Staff house was run up on wooden pillars to support a thatched roof. Bush wood was used throughout, since we could not wait for a supply of palm ribs, which, being less favoured by white ants, are generally employed for roofing. The walls were made of rough grass mats. These mat walls were gradually replaced by laterite without removing the roof, which projects 4 feet beyond them. The house is three-roomed, with, in addition, the usual offices. Floor space is 1,600 square feet, height at centre 14 feet, and at eaves 8 feet. The walls are everywhere protected by the eaves from sun and rain, the floor is cement, and the total cost, including windows and doors, is in the neighbourhood of £300. In connection with the house, there are two special features which ought to be an adjunct of every Bush House or, indeed, of any house in the country—namely, a filter and a mosquito house. A motor house has also been erected.

A farm store, 60 by 20 feet, of laterite with thatch roof is under

construction, and should be finished within six weeks from date. In the meantime temporary tool and material stores made of bush wood and grass are in use, but are very unsatisfactory. A light carpenter's shed and wood store has also been erected.

Two villages have been made: one on the residential area and the other on the strip of land between the farm and the main road. The houses are reasonably well made of bush wood, palm ribs, and grass after the native fashion. There are forty-two of these in the labourers' lines, and fourteen in the Staff lines.

The building programme for next year will comprise a second Staff house, two concrete tanks, and a small pump house. The second Staff house will be larger than the first and about 100 yards from it.

Water Supply.—Four wells have been sunk. One was abandoned at about 60 feet owing to hard rock; one had to be left unfinished owing to the rains; one struck a very little water at 80 feet, which afterwards dried up; and the fourth, near it, yields about 16 gallons a day. Arrangements are, happily, being made for a piped supply from a river a mile and a quarter distant. While still under consideration, it is expected this source of supply will prove sufficient for the use of the villages and Staff houses, and will also be available for enough irrigation to ensure a supply of vegetables during the dry season. The importance of such a supply from the health point of view cannot be exaggerated.

Climate.—Records have been kept daily, since the arrival of instruments in March, of temperature and rainfall. Extracts are appended:

	March.	April.	May.	June.	July.	August.	Sept. (to 15th).
<i>Temperature: (Degrees F.)</i>							
Average maximum ..	97	95.5	91	86	83	83	86
Average minimum ..	71	72	76	71	70	70	70
Greatest diurnal varia- tion {	(26th) 34	(3rd) 40	(12th) 24	(4th) 18	(8th) 17	(2nd) 17	(12th) 19
Greatest maximum ..	103	100	96	91	87	88	88
Lowest minimum ..	68	60	70	66	67	67	68
Average diurnal varia- tion	26	23.5	15	15	13	13	16
Lowest diurnal varia- tion {	(5th) 10	(30th) 7	(19th) 11	(18th) 8	(22nd) 3	(5th) 8	(9th) 12
<i>Rainfall:</i>							
Number rainy days ..	0	4	9	11	16	21	8
Inches rain ..	0	1.13	6.33	9.94	9.89	14.67	3.68
Greatest day rainfall .. {	(30th) 0	(24th) 0.55	(11th) 1.5	(18th) 1.75	(29th) 1.33	(2nd) 4.5	(2nd) 1.1
Lowest day rainfall .. {	(25th) 0	(16th) 0.15	(15th) 0.25	(31st) 0.1	(28th) 0.08	(3rd) 0.01	(3rd) 0.02

So far as we have experienced it—and there are only two months of a full year in which we have not—neither Mr. Browne nor myself can take exception to the climate. We have experienced much more trying climates in both tropical and sub-tropical zones. At the same time, in view of what appears to be the general opinion throughout the country with regard to climate, we are careful to add, in expressing our views, that we refer to our own particular station only. In view of the large difference between day and night temperatures, precaution against chill is necessary. Probably due to our appreciation of this fact, and certainly due to the mosquito house and the large filter, neither of us have been a day on the sick list.

Labour and General.—There was, at first, considerable difficulty with regard to labour. The Emir and the Headman of the district were very helpful, but it was plain that every effort should be made to establish a permanent labour staff. By the middle of June we were in a position to dispense with outside help, and up to the present have an average of between 80 and 100 men a day. The men are good workers under supervision, and our headmen are being gradually trained to a sense of responsibility and knowledge of the work.

Visits to Sokoto, Kano, and Katsina have given us a general knowledge of the conditions in the Northern Provinces, which should prove valuable.

So far no experimental work has been done, but a little lubia (an Egyptian edible bean) and Hubam clover have been sown. The clover is growing but has no root nodules. The lubia (I am unaware if it has been grown before in the country), on the other hand, is exceptionally well provided with nodules and has a luxuriant growth. It is a bean which has, I believe, a European market, and consequently may become a valuable crop in the necessary leguminous rotation.

WEST INDIES

REPORT ON COTTON RESEARCH WORK CARRIED OUT AT THE EXPERIMENT STATION, ST. VINCENT, BRITISH WEST INDIES, 1925-26

BY

L. H. BURD, M.A., DIP. AG. (CANTAB.).

INTRODUCTION.

As is now well known, the Empire Cotton Growing Corporation is establishing a cotton research station in Trinidad, and the small Experiment Station here is being closed down at the end of this season. Much incomplete work, of which an account would normally be held over until later, is therefore included here.

SPACING EXPERIMENTS WITH SEA ISLAND COTTON—II.

These experiments were begun during the season 1924-25, and the results of the first year's working have already been reported (⁶), but as the method adopted was somewhat unusual, it will be as well to repeat here a brief description of the plan of the experiment and of the results obtained.

The principle consists in arranging the plants in rows in which the inter-plant distances become smaller and smaller in one direction. When several rows of this kind are placed side by side, the plants may also be looked upon as being arranged in columns at right angles to the rows, the distances between the columns obviously varying in exactly the same way as the distances between the plants in each row. Each column, then, consists of a series of plants at one particular spacing, and by estimating the yield of each column separately and calculating the yield per unit area, the figures should form a tolerably smooth space yield curve (see sketch plan, Fig. 1). Utilizing this principle we reached the following conclusions:

"The true optimum spacing of plants appears to be 17 inches at one per hole. With two plants per hole the optimum is a trifle wider, about 19 inches. At 18 inches it appears to be immaterial whether the plants are left one or two per hole. At all spacings wider

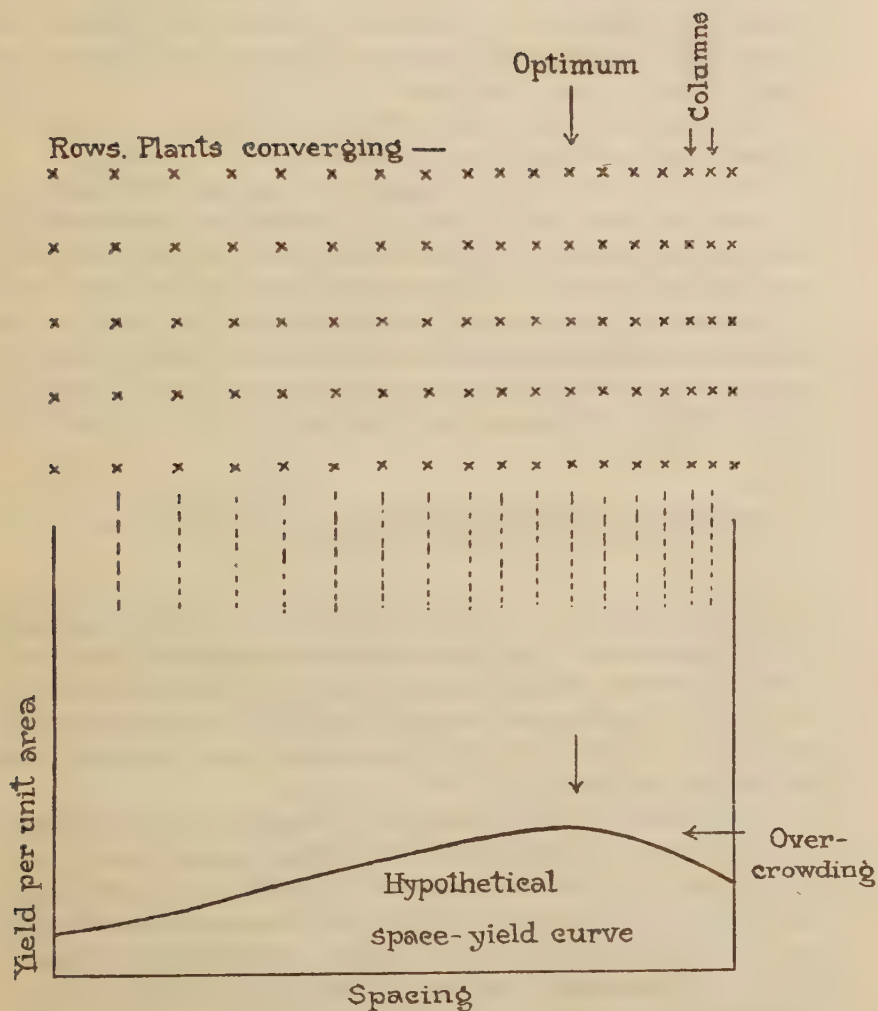


FIG. 1.—SKETCH PLAN ILLUSTRATING THE PRINCIPLE USED IN THE SPACING EXPERIMENTS.

than 19 inches the two per series will give superior yield, and the wider the spacing the greater the superiority.

"There is also a time factor concerned. The earlier the comparison between the one and the two per hole series is made, the greater is the superiority of the latter—i.e., if there is any danger of a loss of bolls at the end of the season, then it would certainly be wiser to leave two plants per hole.

"The plants should certainly never be closer than 16 inches, as this will involve a decrease in yield per unit area."

In the season 1925-26 we decided first to try an experiment on the same lines with variable distances between the rows instead of the plants, and secondly, to repeat the last year's arrangement so as to test more fully the shape of the space yield curve at its mode. An adjustment was introduced for avoiding the marginal effect at the dense end of the plots by arranging the plants, or rows, in the variable row test, so that the shortest distance between them was in the middle of the row, the distances getting greater and greater on either side, thus:



For the experiment with variable distances between the rows two plots were used. The plants were spaced at 18 inches in the rows, and the inter-row distances varied from 2 feet 9 inches to 4 feet 9 inches, by 3-inch steps (see plan, Fig. 2). The plants were left one per hole on both plots. This arrangement gives in all four rows of plants at each spacing.

The collection of data was simple. Flowering records were made daily for each row separately, and bolling records weekly. An approximation to shedding was made by subtraction of the totals. After they came in from the field, the records were calculated to yield per unit area and plotted on squared paper. In order to attain reasonably smooth curves the figures were smoothed by overlapping 3-space means.

The Flowering Records (see Fig. 3).—The curves of flower production per unit area were remarkably smooth and regular. At first there is very little to choose between the various spacings, but as flowering goes on, it becomes clear the 3 feet 3 inch rows are producing more flowers per square yard than any other, and the greater the deviation from this spacing the less the yield. After October 24, when flowering has to all intents and purposes ceased, the wider

Plan of half plot.

For plots 10 and 11. Variable row distances.

Inter row distances increasing from centre by 3 inch steps.

Plants 18 inches in rows.

Strain B.F.

Centre of plot.

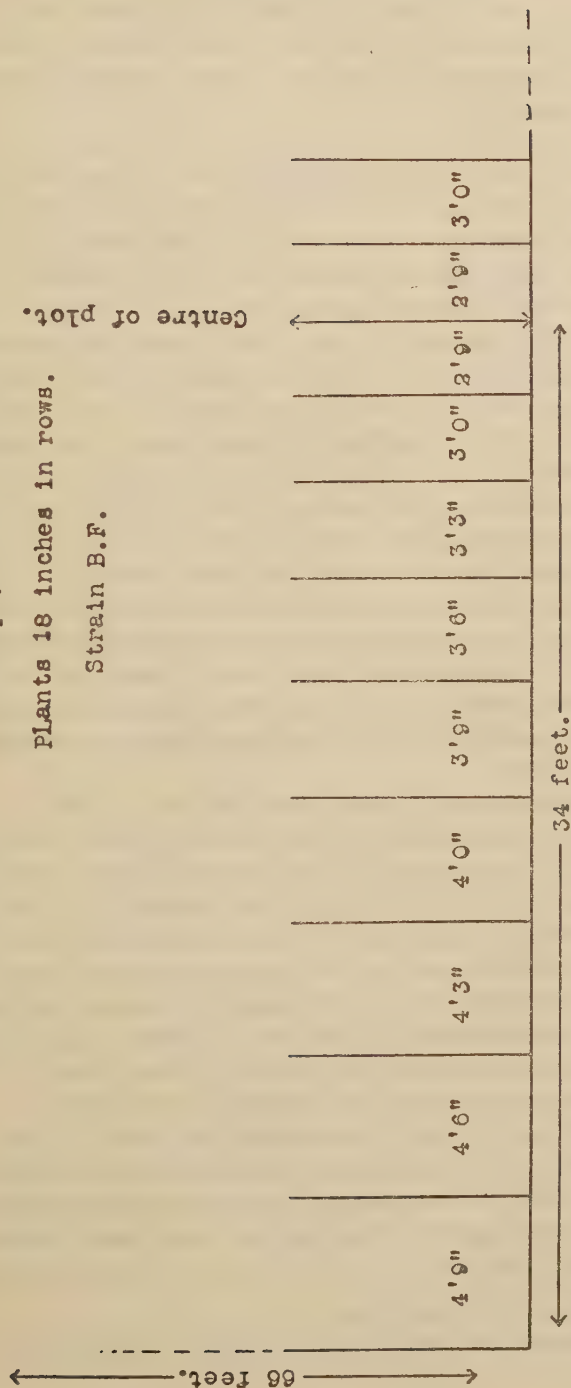


Fig. 2.

spacings have almost if not completely drawn level. At the very end of flowering on November 1 we see that the 4 feet 6 inches has just beaten the 4 feet 3 inches. This is doubtless due to the marginal effect [see (°)].

The Bolling Records (see Fig. 4).—An exactly similar state of affairs is reflected in the bolling curves. Here, as before, there is little to choose between the various spacings at first, but the 3 feet 3 inch rows soon begin to show their superiority. Again, this superiority grows less towards the end of the season, but it is to be noticed that the wider spacings never quite succeed in catching up. The fall in yield per unit area is very marked in the closer rows.

Shedding.—From the figures obtained by subtracting total bolls produced from total flowers produced, for each spacing, it would seem that there is considerably less shedding in the close-spaced rows. Incidentally it is interesting to notice that though the losses were exceptionally low, yet the final yield is of quite normal magnitude; even in the optimum it does not work out to more than 360 pounds* or a bale of lint to an acre. As an explanation of the unexpected result that the wide rows should shed more than the close, it may be that had the plots been observed for a little longer than the wide rows might have opened a few more bolls. This might be expected since the bolling does not quite follow the flowering at this point. Since no direct shedding data are available, further speculation would be unprofitable.

Conclusions.—It would seem that we can safely say that 3 feet 3 inches is the optimum distance between the rows when the plants are spaced 18 inches apart. If the rows are spaced wider than this, the decrease in yield per unit area will be small if all the late bolls are successfully harvested; if, however, it is desired to obtain the maximum crop in the shortest possible time, or there is danger of losing the late bolls through pests, such as pink bollworm, then the advantages of the closer spacings will be more apparent. In any case, the rows should never be closer than 3 feet 3 inches or there will certainly be a decrease in yield per unit area from overcrowding.

The results from the experiment with variable distances between the plants in the rows are far less satisfactory (see Figs. 5A and 5B). The general plan was the same as that used last year except that, as previously mentioned, the smallest inter-plant interval was in the middle of the row to avoid a marginal effect, the plants diverging

* When a St. Vincent planter refers to yield of "a bale an acre," he means 320 pounds of lint per acre, although the lint is not now put up in bales of this size.

NO. OF FLOWERS PER SQU

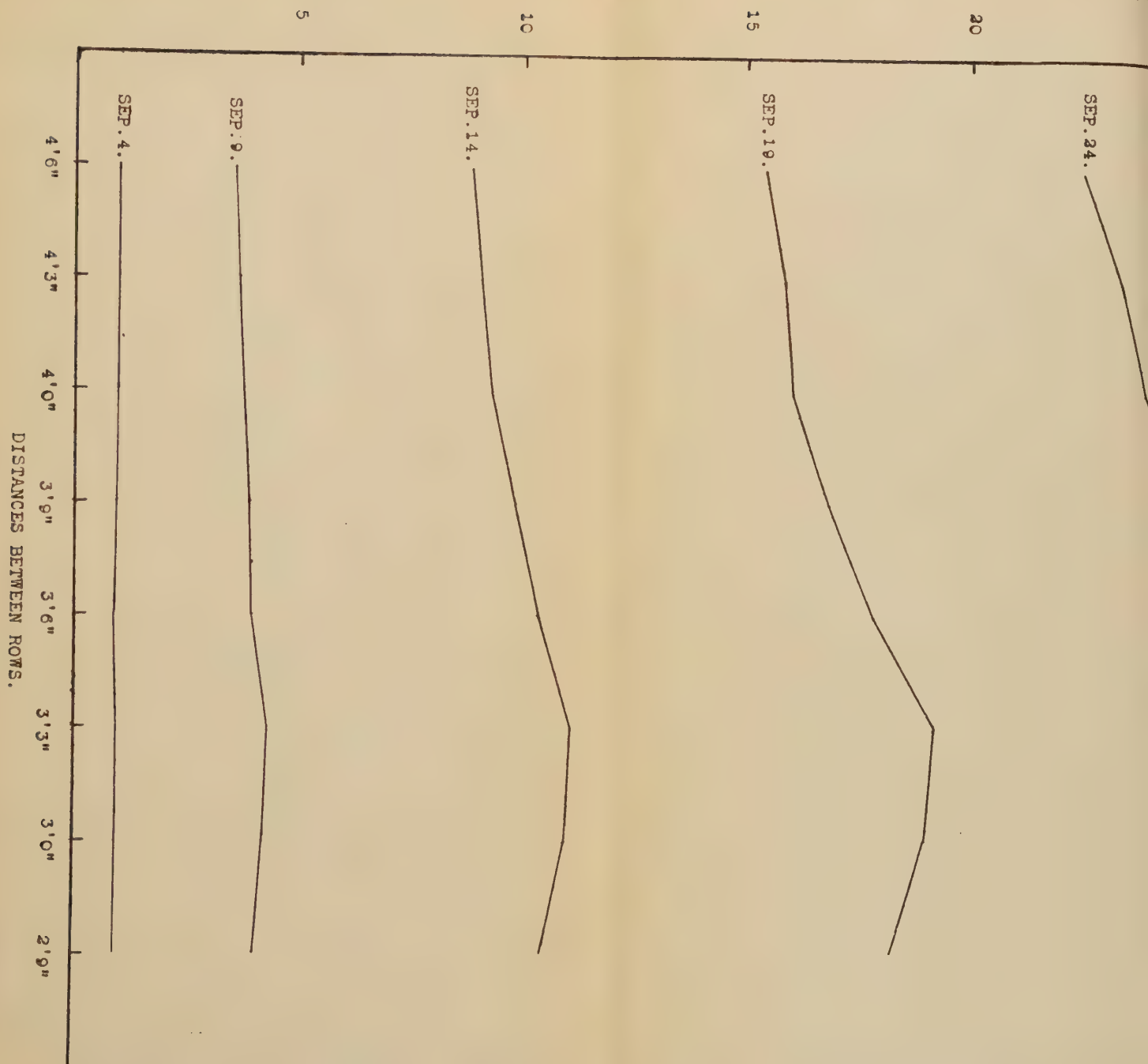


FIGURE 3.
 CURVES OF FLOWER PRODUCTION FOR VARIOUS INTER-ROW DISTANCES.
 Plots 10 and 11.



NO. OF BOLLS PER

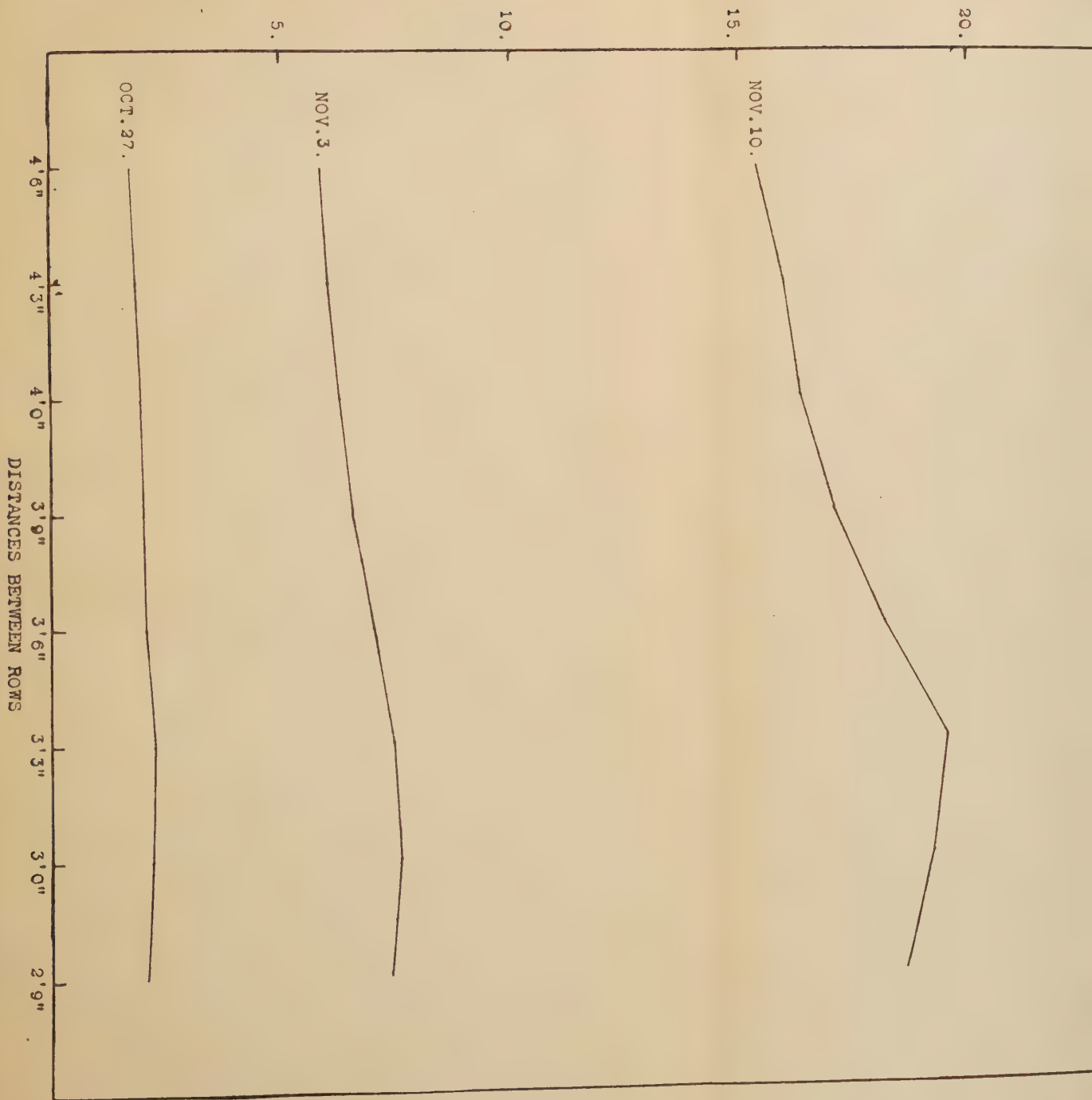
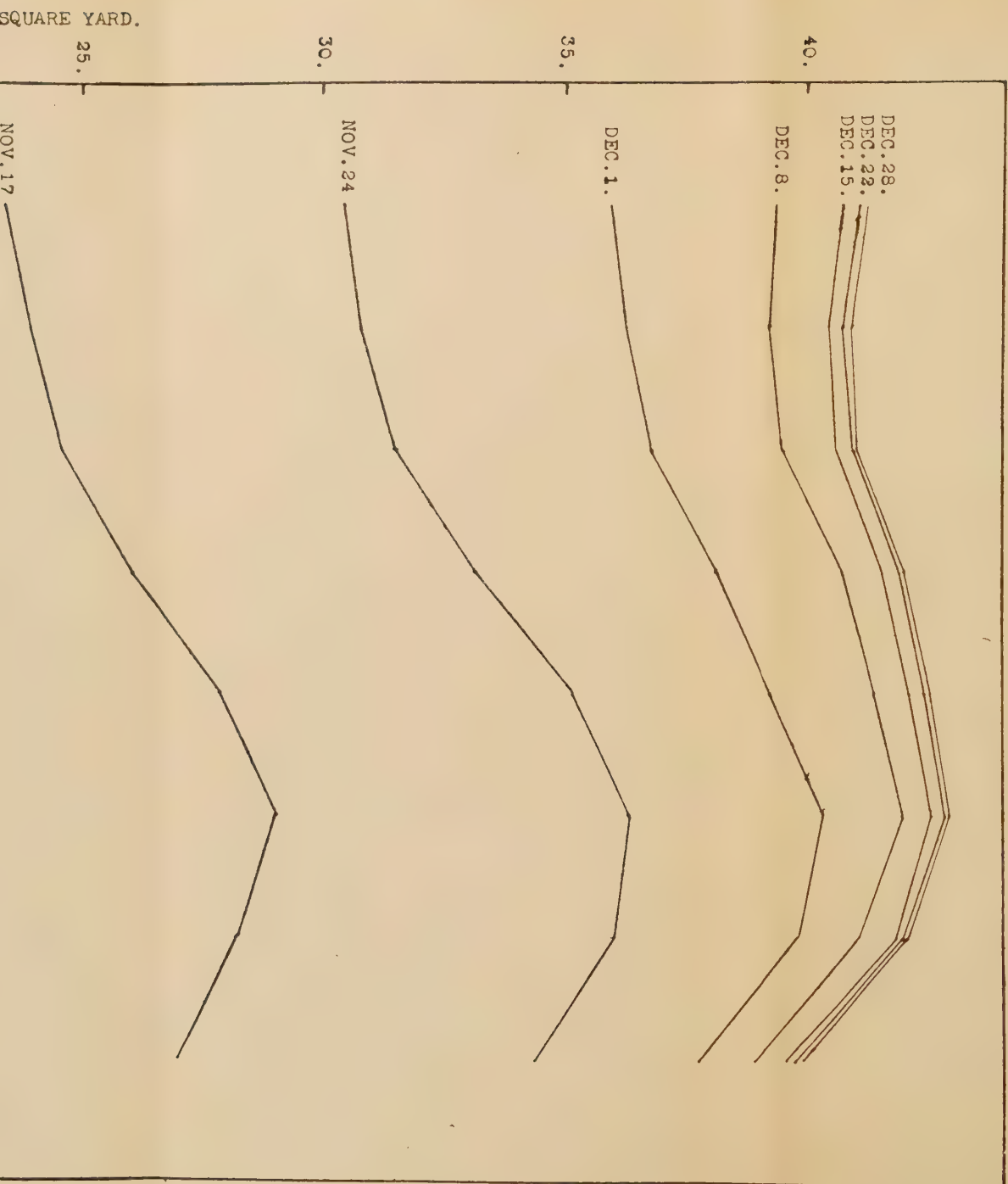


FIGURE 4.

CURVES OF BOLL PRODUCTION FOR VARIOUS INTER-ROW DISTANCES.
Plots 10 and 11.



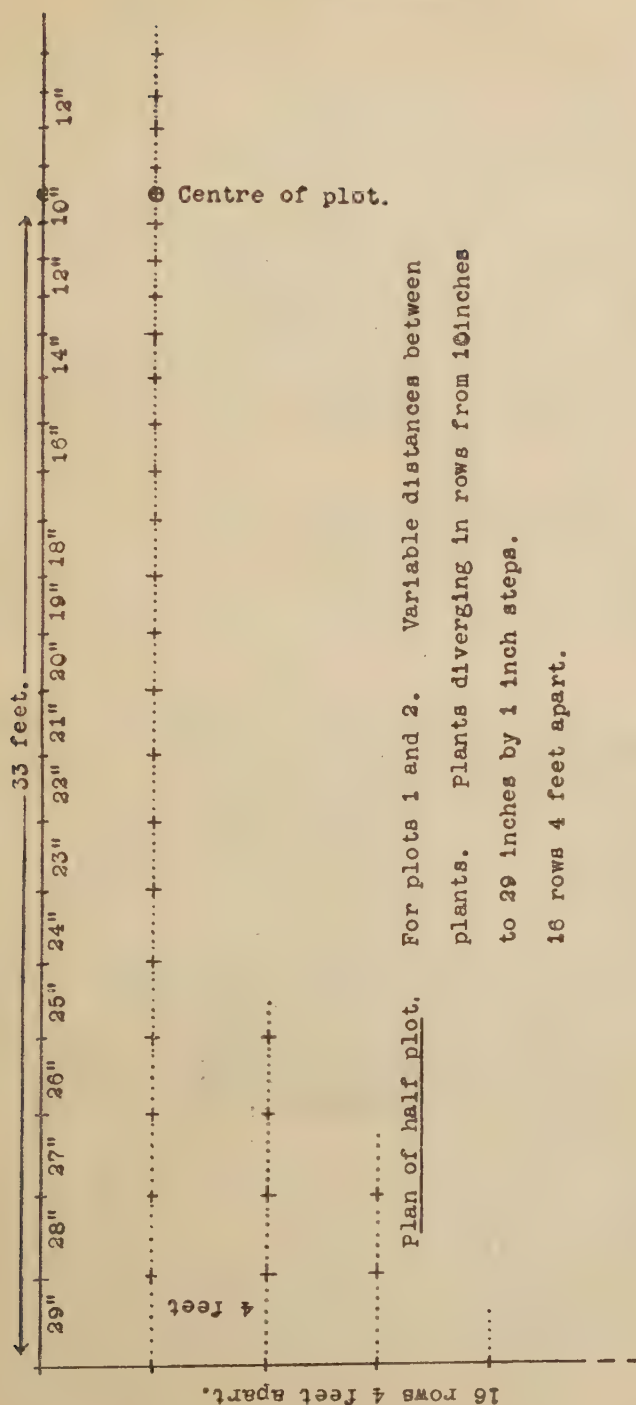


FIG. 5A.

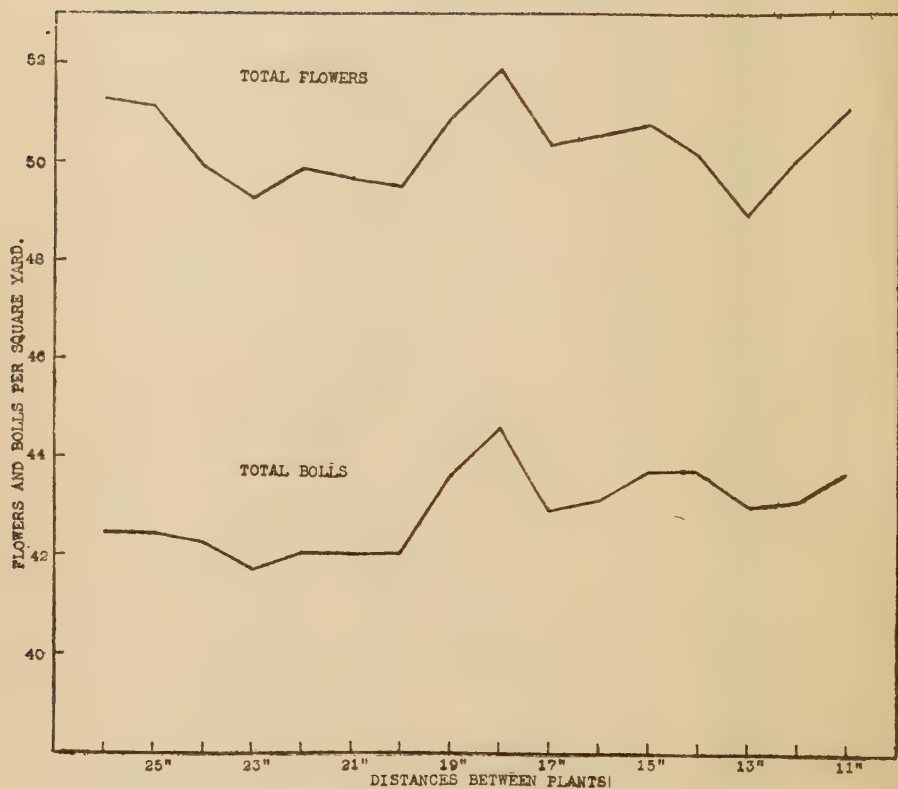


FIG. 5B.—TOTAL FLOWER AND BOLL PRODUCTION FOR VARIOUS INTER-PLANT DISTANCES.
Plots 1 and 2.

outwards on both sides from 10 to 29 inches by 1-inch steps. There were two plots, each consisting of sixteen such rows, the rows being 4 feet apart (see plan). Daily flowering and weekly bolling records were taken in the same manner as last year, and curves for total flower and boll production are produced. The correspondence in shape between the two curves is evidence that the records were made with considerable accuracy.

Beyond this one can say that they demonstrate beautifully how the effects of soil heterogeneity have vitiated the results of the experiment. There is indeed a peak at spacing 18 inches, which is approximately where one would expect it from last year's results, but the absence of a progressive and continuous fall on either side, as the plants become wider or closer, renders it quite inconclusive. Four repetitions—*i.e.*, two halves each of two plots—are evidently not nearly enough.

Reviewing the method as a whole, it would seem that a very much larger number of repetitions is necessary to ensure accuracy, and that the soil of plots 1 and 2, on which the variable inter-row distance experiment was conducted, was, fortunately, exceptionally uniform.

TESTING TWO VARIETIES OF SEA ISLAND COTTON.

For some years now mass selections for a large boll have been carried out by the Foreman of the Experiment Station, the selections being based on eye judgment in the field. It was felt that though a type with a larger boll than usual had undoubtedly been established, the yielding capacity of the strain might not have been increased, owing to a concurrent decrease in the number of bolls per plant. Accordingly we decided to test it against our strain AN, which is one of our heaviest yielders and about which we have an unusually complete set of data. Considerations of space prevented us from taking a multiple plot test on a large scale, so we chose instead the method of alternate rows in a single plot.

The plot consisted of eight strips of each variety, arranged as follows:

A B B A A B B A A B B A A B B A.

The comparison between the two types is then calculated from the series of differences $A - B$ between the adjacent rows. Notice that the pairs are arranged so that in one case variety A is in the left, and in the next variety B. This will tend to prevent any continuous variations in soil fertility across the plot from affecting the two varieties unequally.

TABLE I.

	Big Boll.	AN.	AN.	Big Boll.	Big Boll.	Big Boll.	AN.	AN.	Big Boll.	AN.	Big Boll.	AN.	Big Boll.	AN.	Big Boll.
Total yield as flowers per plant	39.58	37.79	45.83	51.21	51.68	50.57	48.09	44.52	41.05	43.26	46.19	48.58	43.00	51.71	52.38
Differences ..	- 1.79		- 5.38		- 1.11		+ 3.57		+ 2.21		- 2.39		+ 8.71		- 2.01

Omitting outside pairs.

Mean difference AN greater than Big Boll by 0.935 flower per plant.

 $Em = \pm 1.25$, hence no significant difference.

TABLE II.

	Big Boll.	AN.	AN.	Big Boll.	Big Boll.	Big Boll.	AN.	AN.	Big Boll.	AN.	Big Boll.	AN.	Big Boll.	AN.	Big Boll.
Losses between flowering and bolling (by sub-traction)	—	—	8.88	13.85	14.38	12.06	10.22	11.30	8.29	9.06	18.20	22.02	15.55	19.03	—
Differences ..	—		+ 4.95		+ 2.32		+ 1.08		- 0.77		+ 3.82		- 3.48		—

Mean of differences = 1.32 sheds per row.

 $Em = \pm 0.802$, hence AN sheds less than Big Boll selection, and the difference is possibly significant.

TABLE III.

	Big Boll.	AN.	AN.	Big Boll.	Big Boll.	Big Boll.	AN.	AN.	Big Boll.	AN.	Big Boll.	AN.	Big Boll.	AN.	Big Boll.
Total yield as bolls per plant	28.53	31.61	36.95	37.36	37.30	38.51	37.87	33.22	32.76	34.20	27.99	26.56	37.45	32.18	33.51
Differences AN over Big Boll	+ 3.08		- 0.41		+ 1.21		+ 4.65		+ 1.44		+ 1.43		+ 4.73		- 5.28

Omitting outside pairs. Mean Big Boll, 32.44; mean AN, 34.62.

Mean difference = 2.18 bolls per plant.

Mean of actual differences equals 4.2 times its probable error, hence almost certainly significant.

 $Em = \pm 0.518$.

For the actual purpose of making the comparison, flowering and bolling data were obtained: flowers daily and bolls weekly.

When plotted on squared paper as flowers and bolls per plant per day very little difference between the two strains could be observed.

The big boll selection was slightly ahead at the beginning of the flowering period, but their rates were about equal when flowering was in full swing, and AN drew ahead as the rates declined.

The same state of affairs was noticed for the bolling, the superiority of AN at the end of the period being a little more marked than it had been for flowering. Actual yields as flowers and bolls per plant are given in Tables I. and III. For flowering AN is slightly superior, but since the mean difference of the pairs is less than its probable error, evidently no significance whatever can be attached to this. In bolling, on the other hand, the increase of AN over the big boll selection is more marked, and is 4.2 times its probable error. Hence it seems certain that AN really does produce more bolls. Since, however, there is no significant difference in flower production, it follows that the superiority of AN must lie in its resistance to losses between flowering and bolling. An estimation of these losses by subtraction is given in Table II.

The difference between the two strains in this respect is very small, but the mean difference is nearly twice its probable error, and is possibly significant.

The lint per boll figures for the two strains are (1924 crop):

Big Boll selection	..	..	..	..	..	1.10 grammes.
AN	..	..	..	..	..	0.96 „

Taking the figures for mean bolls per plant we can now compare the actual yield of the two strains.

				<i>Bolls per Plant.</i>		<i>Lint per Boll.</i>		<i>Lint per Plant Yield.</i>
Big Boll selection	..	..	32.44	×	1.10	=	35.8	grammes.
AN	..	..	34.62	×	0.96	=	33.2	„

Thus we see that the big boll selection has yielded slightly more cotton than AN in spite of its having a smaller number of bolls per plant.

THE INHERITANCE OF COROLLA COLOUR IN SEA ISLAND COTTON.*

During the season 1923 three plants with quite white flowers were noticed in a plot of our pure strain AN. Their petal colour stood out in clear contrast to the full golden yellow of the normal

* This account has already appeared in *Tropical Agriculture*, March, 1926, Vol. III., No. 3

flowers, though in all other respects the eye could not distinguish the plants from their neighbours. A considerable quantity of selfed seed was secured from them, and the crop in the following season showed that the new type was breeding true. We afterwards found that this new white-flowered strain (referred to in future as ANW) could also be distinguished from the normal AN by its shorter lint length, the actual mean maximum lengths being 48.1 and 50.9 mm. respectively. Here, then, was some excellent material upon which to begin investigations on the inheritance of flower colour, and the possible relation between it and lint length.

The genetics of flower colour in cotton has already received attention from other workers. In crosses between yellow and white, Balls¹ in Egypt found that the F1 was invariably intermediate, but the F2 and F3 results were complex and indicated that there were not less than three pairs of allelomorphs concerned. Leake,² on the other hand, in a like cross with Indian cotton, found that yellow was completely dominant in F1, and his F2 segregated cleanly into yellow and white, but the proportions were not in accordance with any simple Mendelian ratio.

The work to be described has at present only been carried as far as F2, but as there is no immediate prospect of its being continued, and the conclusions reached are different from those obtained by either of the workers quoted, it seems worth while to put the meagre results on record.

Crosses were made between AN and ANW as early as possible in the 1924 season, and mature seed was obtained towards the end of October. In order to try and save a year, it was decided to sow these seeds at once and so raise and harvest the F1 before the close season began on April 1, 1925. The parental types were also sown at the same time for comparison purposes.

The seeds were successfully germinated in moist sand⁴, and an F1 of sixty-two plants raised. Every plant had pale yellow petals intermediate between the two parents. Unfortunately, as soon as flowering was well under way, at about the middle of January, pink bollworm became rampant, and despite every precaution in the way of bagging flowers and even netting one plant, the attack was so bad that from the sixty-two plants only forty sound selfed seeds could be obtained from which to grow an F2.

Of these forty seeds, thirty-seven germinated and grew into healthy plants in 1925. The first classification of this F2 gave the results set out in Table IV. There was no doubt whatever about the extracted white-flowered plants, and the case seemed to have resolved itself

into a simple 1:2:1 ratio. Repeated matching, however, showed that the matter was by no means so simple. While there was never any difficulty about the nine white plants, which were picked out consistently by different observers on different days, many of the coloured plants were matched first to one type and then to another, and our final conclusion was that at least three, and possibly four, different shades of yellow were present.

TABLE IV.

FLOWER COLOUR, AN (YELLOW) × ANW (WHITE).

F1	..	..	62 plants.	All intermediate.		
F2	..	..	Yellow.	Intermediate.	White.	
			7*	21*	9	
Ratio	..	..	0.76	: 3.02	:	0.98
					:	0.98

* See text.

While it will be necessary to devise a more accurate system of colorimetric grading, and to carry the breeding at least as far as F4 before a conclusive solution of the problem can be hoped for, the following is suggested as a tentative explanation in Mendelian terms:

That the fundamental difference between the white and yellow-flowered plants is due to a single pair of allelomorphs. That there is also at least one modifying factor, and possibly more, which may control the depth of yellow pigment in coloured individuals.

The possibility of a connection between flower colour and lint length was pointed out earlier.

TABLE V.

AN × ANW. F2. KEY-FREQUENCY POLYGON. LINT LENGTH.

				36							
				33							
				31							
				30*							
				29*							
				28*							
			34	22		25					
		37	32	21		24*					
		35	26	16		15					
		17	23*	13	20*	8					
		4	11	9	18	6					
	27	3	7*	1*	12	5	19	10	14*	2	—
Mean maximum	45	46	47	48	49	50	51	52	53	54	M.
8 seeds in mm. . .	1	5	6	12	3	6	1	1	1	1	48

Extracted whites marked with a star.

Unfortunately, owing to an oversight, the F1 seeds were ginned before their lint length had been measured, so that no figures are available for them; the F2, however, has been measured for mean maximum lint length, and the results are given in Table V. In this key-frequency polygon the extracted whites are marked with a star.

There is evidently no tendency for the white colour to be associated with either long or short lint. It is curious that though the two characters, white flower and short lint, both arose, as far as we know, at the same time, they should apparently be inherited entirely independently of one another.

INHERITANCE OF PETAL LENGTH.

The plant character petal length is remarkably uniform. Examination of five flowers gives a mean with a probable error of only one-half of 1 per cent., all five petals being measured to the nearest millimetre on each flower. Some preliminary trials on two strains gave results as follows:

V135.			
Five flowers	..	..	M=52.76 mm. ± 0.49 per cent.
Another five	..	..	M=52.40 mm. ± 0.55 "
Twenty flowers	..	..	M=51.99 mm. ± 0.27 "
AN.			
Five flowers	..	..	M=64.44 mm. ± 0.57 per cent.
Another five	..	..	M=63.44 mm. ± 0.47 "
Twenty flowers	..	..	M=63.70 mm. ± 0.22 "

The character has been examined in the P1 and F1 generations of several crosses, twenty flowers—*i.e.*, 100 measurements being made in each case.

(I.) V135 $\times$ AE.

V135.	F1.	AE.
51.99 ± 0.27 per cent.	61.88 ± 0.26 per cent.	60.44 ± 0.39 per cent.

Here long petal is completely dominant over short, and there is slight heterosis.

(II.) V135 $\times$ AJ.

V135.	F1.	AJ.
51.99 ± 0.27 per cent.	59.92 ± 0.37 per cent.	62.48 ± 0.33 per cent.

Here the F1 is intermediate, though very much nearer to the long parent.

(III.) BD $\times$ AJ.

BD.	F1.	AJ.
59.94 ± 0.24 per cent.	60.76 ± 0.35 per cent.	62.48 ± 0.33 per cent.

Here the difference between the two parents is small and the F1 intermediate, though nearer the short parent.

The validity of the difference in petal length between the two parents is not obvious and needs to be tested.

Using the usual formula $Ed = \sqrt{Em_1^2 + Em_2^2}$ we get $Ed = \pm 0.498$ per cent.—*i.e.*, the actual difference between the two means is 6.2 times its probable error, and may certainly be considered significant.

INHERITANCE OF LINT LENGTH, LINT WEIGHT, AND SEED WEIGHT.

These characters have now been examined as far as the F3 generations in one cross, and as far as F1 in three others. The respective F4's and F2's have been grown this season, and are now in process of examination.

It is hoped that a complete account of the story will be published elsewhere in due course, and only a brief résumé of the situation will be given here.

The characteristics of the various pure strains used as parents are as follows:

H23.

Mean maximum length of lint, 50.9 mm.

Mean lint weight on 100 seeds (in grammes), 5.57 gr.

Mean weight of 100 seeds (in grammes), 13.25 gr.

(This strain was originally imported from Montserrat.)

V135.

Mean maximum length of lint, 56.7 mm.

Mean lint weight on 100 seeds, 3.8 gr.

Mean weight of 100 seeds, 12.95 gr.

(This strain has the longest lint of any known cotton.)

AE.

Mean maximum length of lint, 52.1 mm.

Mean lint weight on 100 seeds, 5.01 gr.

Mean weight of 100 seeds, 15.0 gr.

(Has an unusually high seed weight.)

AJ.

Mean maximum length of lint, 51.0 mm.

Mean lint weight on 100 seeds, 5.77 gr.

Mean weight of 100 seeds, 13.6 gr.

(Not a successful strain commercially owing to its propensity to shedding.)

BD.

Mean maximum length of lint, 51.4 mm.

Mean lint weight on 100 seeds, 5.22 gr.

Mean weight of 100 seeds, 13.6 gr.

Cross H23 $\times$ V135.

F1.—Mean maximum length of lint, 54.3 mm.—*i.e.*, intermediate but distinctly nearer the long parent.

Mean weight of lint per 100 seeds, 4.84 gr.—*i.e.*, intermediate but nearer to H23.

Mean weight of 100 seeds, 13.6 gr.; slight heterosis.

For all these characters the F1 variability was the same as that of the parents.

F2.—The character mean maximum length of lint split up with a multi-modal distribution covering the range of both parents, and it seemed at this point as though a two-factor hypothesis, with slight dominance, would explain the observed results (see St. Vincent Botanic Station Report, 1923). However, the F3 data obtained since have failed to substantiate so simple an explanation.

For lint weight per 100 seeds the distribution was nearly smooth and skew, the modal value being smaller than the mean.

This is curious, seeing that the F2 gave a remarkably smooth distribution, which was exactly symmetrical, the range covering that of both the parents.

F3.—Plants taken from various points on the F2 lint-length frequency curve have given F3 families whose means form a continuous series covering the range of the F1 generations—some of them homozygous and others evidently segregating.

It seems quite clear that we are dealing with a case of multiple factor inheritance, though it has not yet been possible to determine how many factors are at work.

The following considerations support this view:

1. The F1 was strictly comparable to the parental races in uniformity.

2. There was no significant difference between the frequency distributions of the various F2 families.

3. Grand parental types were recovered in F2.

4. Plants from different points on the F2 frequency curve gave F3 families, differing widely in their means and modes, and in none of them was the F3 variability greater than that of the F2 population.

Lint weight behaved in a similar way, but the two characters are not inherited independently. A few plants with high lint weight and long lint did not occur in F2, but the F3 families from these showed that they were merely favourable fluctuations and not genetic recombinations.

Judging by the means of the F3 families, the negative correlations between the two characters is high, $r=0.6 \pm 0.045$, so that the chance of extracting a pure white strain combining both characters is rather remote.

Seed weight in F3 behaves like the other characters, some of the families being apparently homozygous. It is inherited entirely independently of lint length, the F3 family means correlation being $r=0.055 \pm 0.073$, but there is evidently some positive correlation between it and lint weight. Here $r=0.380 \pm 0.062$. This may possibly have a mechanical explanation as follows: other things being equal, a heavy seed means a large seed, and lint weight has been shown to be almost directly proportional to the number of hairs per seed. Now if the proportion of epidermal cells of the seed coat which sprout to form lint hairs to those which do not, remains approximately constant, it is clear that a large seed must mean a seed with large weight of hair, since it will have more epidermal cells and consequently a larger number of hairs.

Cross AE $\times$ V135.

F1.—Here, in contrast to the H23 $\times$ V135, the latter is almost completely dominant for lint length and seed weight. The actual F1 means were lint length 55.7 mm. and seed weight 12.4 gr. Weight of lint is approximately intermediate at 4.4 gr. Seven plants only were raised.

Cross AJ $\times$ V135.

F1.—This cross has so far behaved in exactly the same way as the last, V135 being dominant for seed weight and lint length. The actual means were lint length 56.6 mm., seed weight 12.5 gr. Lint weight was intermediate at 4.55 gr.

Cross BD $\times$ AJ.

F1.—Here there is considerable heterosis for lint length, the F1 mean being 54 mm. Lint weight and seed weight, on the other hand, were slightly lower than either parent.

CRINKLED DWARF ROGUES AND MAN COTTONS.

In a single-plant progeny row of our pure strain GX12 (=C) four crinkled dwarf rogues and one "man cotton" appeared this year.

The "man cottons" are of not infrequent occurrence, and a description of one has already been published.⁷ This popular name,

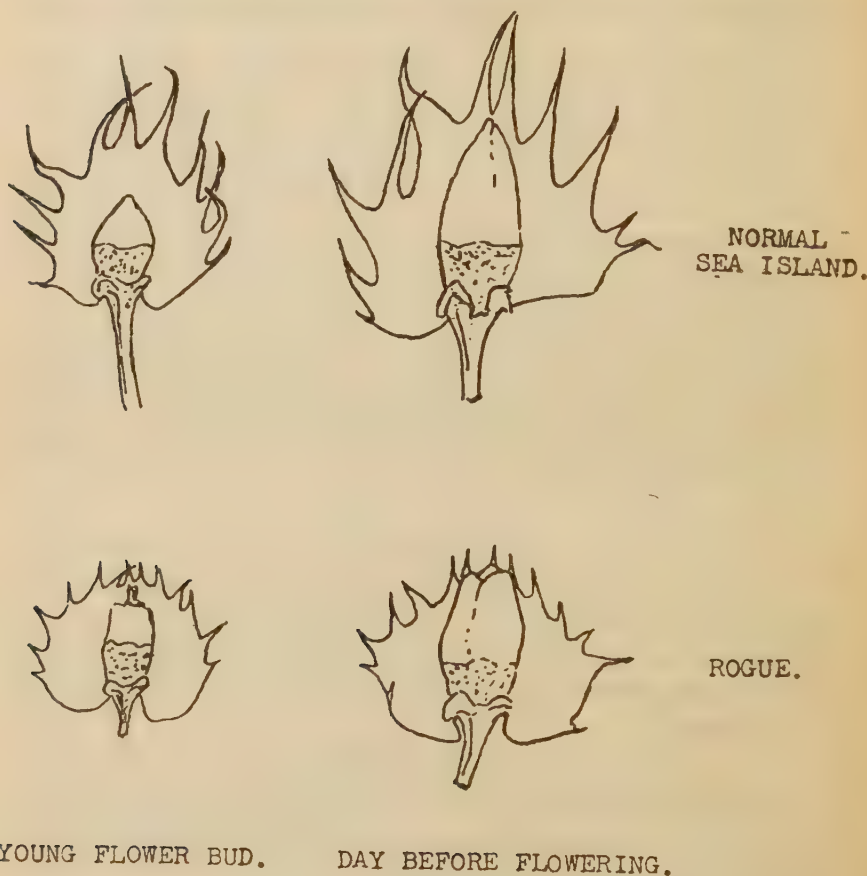


FIG. 6.—CRINKLED DWARF ROGUES.

however, is singularly inept, as the plants are completely male sterile, and shed about 95 per cent. of their bolls.

The crinkled dwarf rogues are small plants, with all the parts reduced in size, the leaves very severely crinkled and of a sickly yellow-green tinge, not altogether unlike the appearance caused by leaf blister mite. They differ from those described by Harland¹⁰ in

that there is no pronounced tendency to produce branches from the accessory bud as well as the bud in the leaf axil, and their propensity for boll shedding is not more marked than usual. A curious feature about the plants is that, although the petals and bracts are much smaller than usual, the style and stigma appear to grow at normal rate, and in consequence can be seen protruding through the petals when the bud is young. As the time of flower opening approaches the petals increase in size and the style and stigma again become invisible (see Fig. 6).

Selfed seed and seed from crosses between rogues and normal have been secured with facility, there being no signs of sterility.

PLANT DEVELOPMENT AND CROP ANALYSIS (FIGS. 7A. AND 7B.)

Routine plant development records have now been obtained for three seasons. They comprise daily growth, flowering, bolling and shedding rates and daily examinations from dated flowers, of lint length, lint weight and seed weight. The general method has been precisely that initiated by Dr. Balls in Egypt,⁵ though the actual technique of the collection of data has been altered slightly to suit our conditions. For the purpose of these records the same plot has been set aside each year, and the same strain (BF) and spacing used, and the manurial treatment merely a green dressing of Bengal beans each season, so that the inter-seasonal variation may safely be considered as due to weather conditions.

A square plot of $\frac{1}{16}$ of an acre was used, the rows being 4 feet apart and the plants 18 inches in the rows (one plant per hole).

The growth records were made daily on a group of 100 plants chosen out of the plot in such a way as to avoid all marginal errors and effects due to stunted or missing plants. The actual measurements were made from an Indian ink mark at the cotyledonary node to the base of the terminal bud, to the nearest millimetre. Flowering and bolling records were taken daily on the entire plot, omitting outside rows.

Boll shedding was estimated by picking up all the fallen bolls in the furrows daily. Since the outside rows were omitted from the flower and boll counts, only *half* the fallen bolls found in the two outer furrows were credited to the plot.

For the study of the daily variations in the contents of the boll—i.e., lint length, lint weight, and seed weight—twenty flowers were dated each day throughout the flowering period, and bolls which opened in due course were picked and collected according to those days. This ensures that we are really grouping together bolls which have passed through the same set of environmental conditions. If daily picking alone were relied upon, there would quite possibly be an error of three or four days in either direction because of the fluctuations in the mean maturation period of the boll.

For the purpose of general discussion, and comparison between the three seasons, all records have been worked up to represent the performance of the average plant, smoothed by overlapping five-day means and plotted on squared paper. As the plants were not sown on the same date each year, from agricultural considerations, actual dates are replaced by number of days after sowing in the plotted curves.

The Growth Records (see Fig. 7A.).—The growth performance of the plants, both as to maximum rate and duration of growth period, differed greatly in the three years.

Examination of the curves shows that in 1923-24 the growth rates were exceptionally high, reaching a maximum of nearly 4 cms. per plant per day at about the 53rd day. Then there was a severe check in growth, culminating on 61st day, from which the plants had recovered five days later. By day 90 growth had to all intents and purposes ceased.

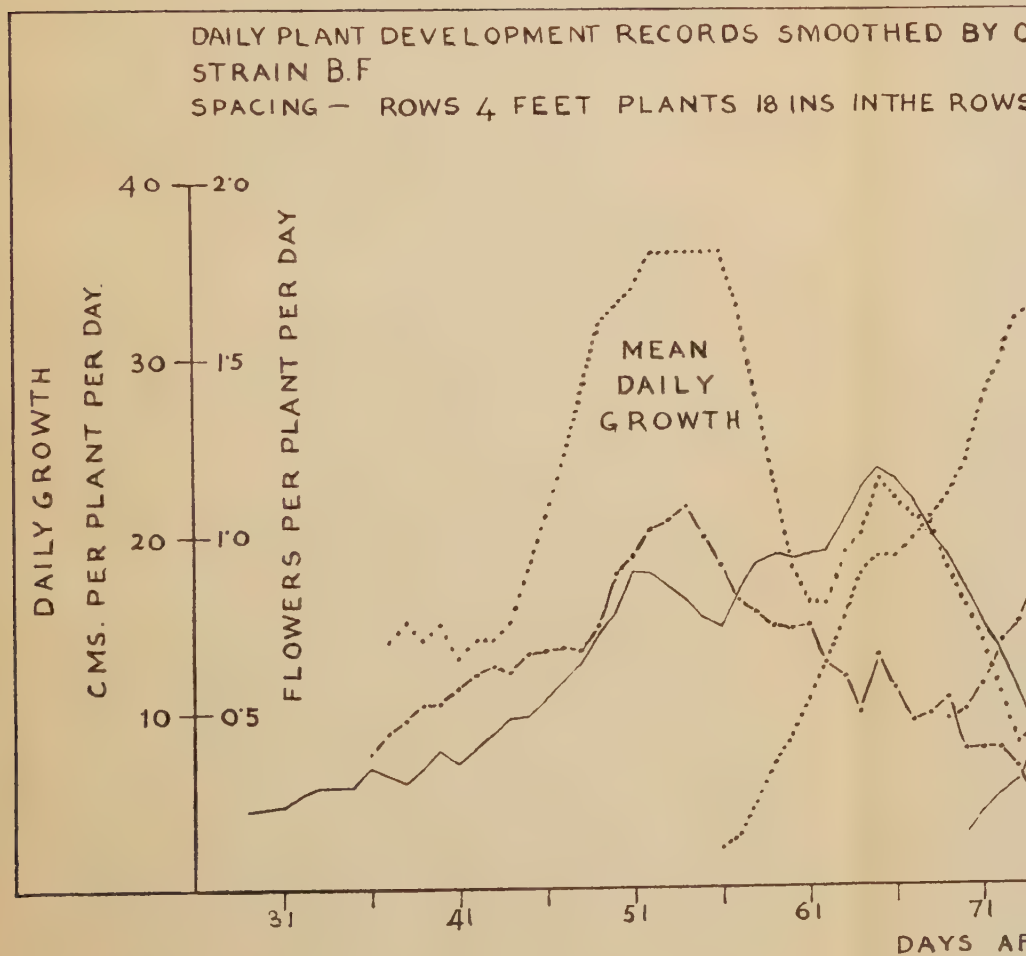
In the next season—1924-25—growth rates were much slower, the maximum, also on day 53, being only 2.2 cms. per plant per day. After this the rates decline slowly and fairly regularly, finally ceasing on 93rd day.

At no time during 1924-25 did the rate equal that at a similar time in the previous year. This state of affairs was almost certainly true of estate conditions where all the plants were noticeably smaller than usual.

In 1925-26 the growth rates at first were slower still. The maximum rate, however, was not reached until day 65—some ten days later than in the previous seasons. After this the rates declined steadily until day 74, when a sharp recovery took place and a second maximum was reached on day 83. From hence onwards the rates again declined, and finally ceased on day 106. This season was characterized by a very long growth period with a very late maximum.

FIGURE

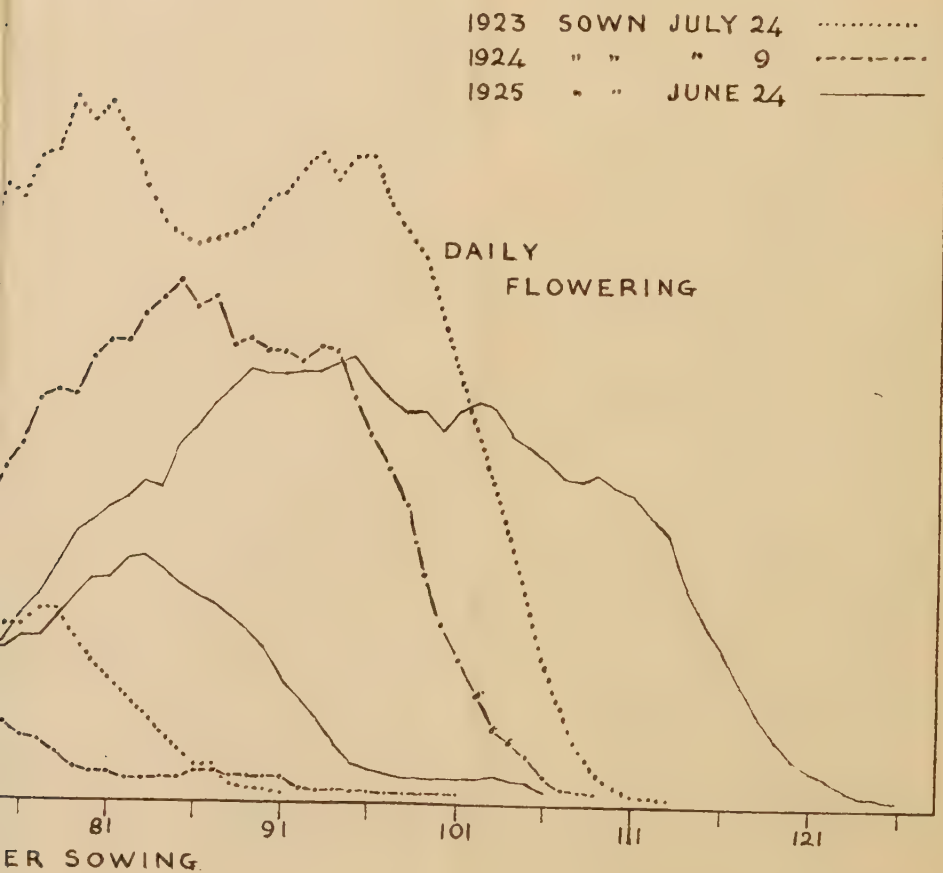
PLANT DEVELOPMENT RE



7A.

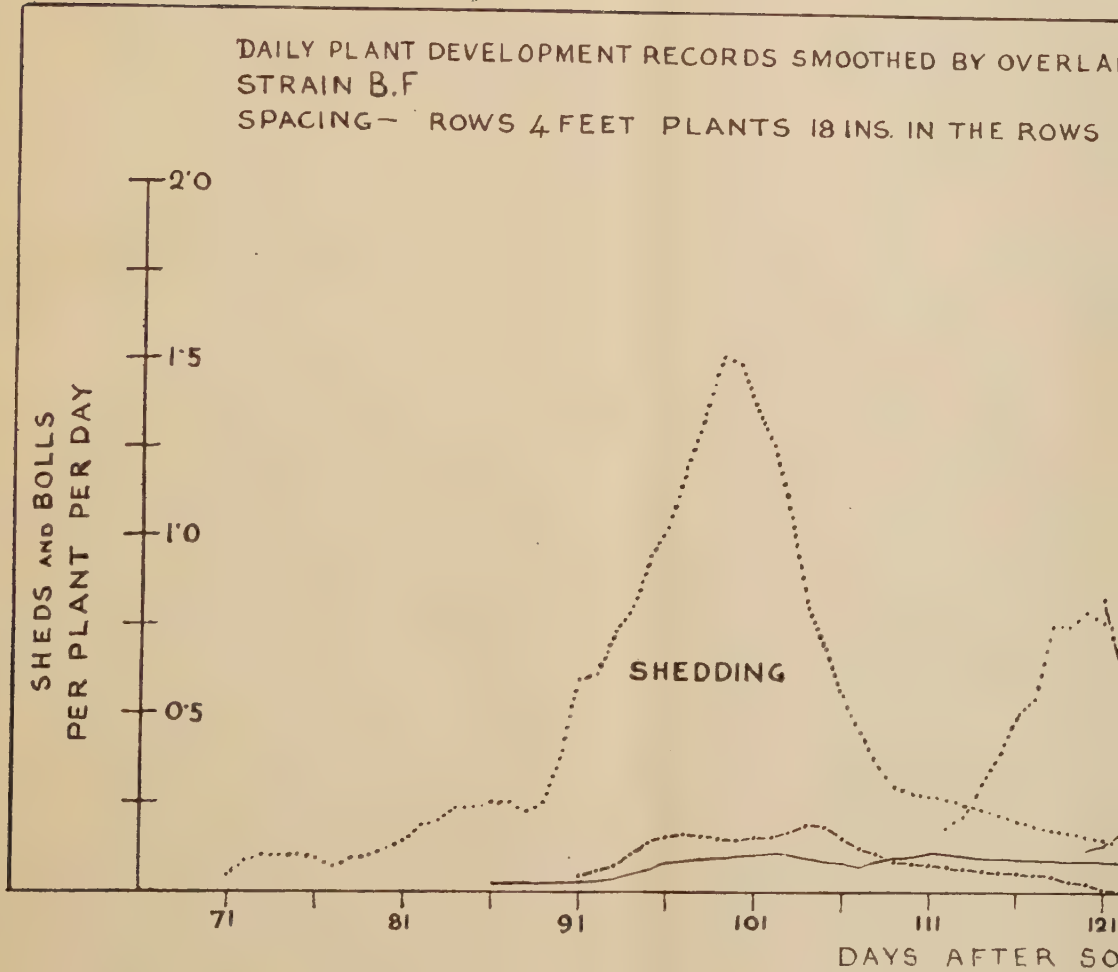
CORDS, ST. VINCENT.

VERLAPPING 5 DAY MEANS



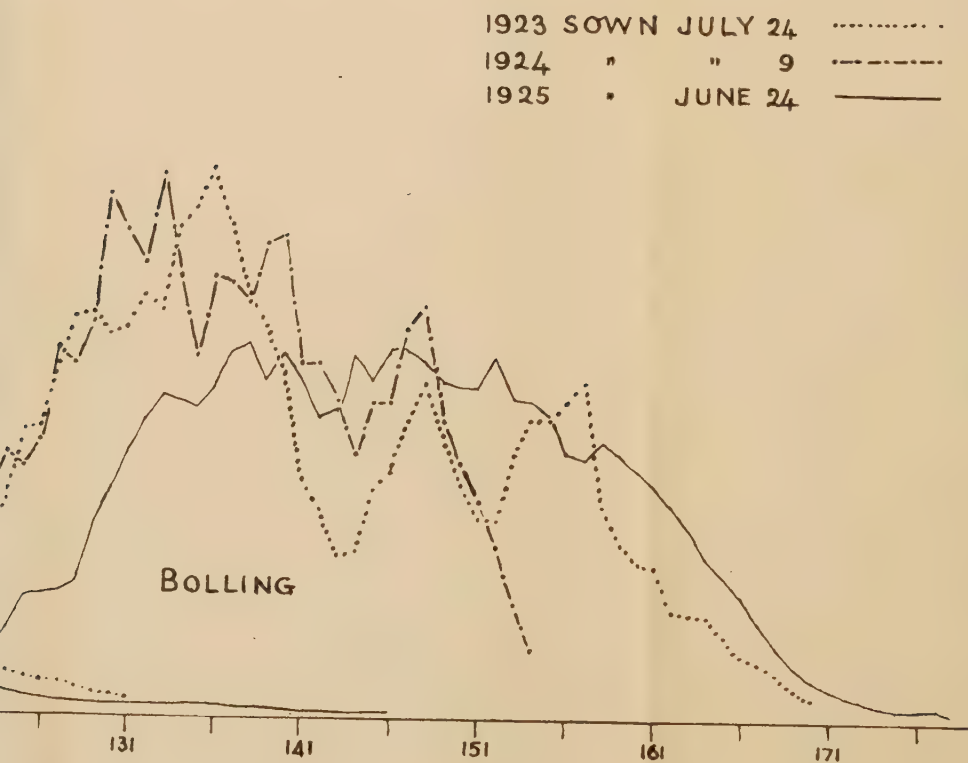
To face p. 226.

FIGURE
PLANT DEVELOPMENT RECORD



7B.
ARDS, ST. VINCENT.

ING 5 DAY MEANS.



ING

To face p. 226.

The Flowering Curves (Fig. 7A.).—These are very largely a reflection of the growth curves.

In 1923-24 flowering was unusually rapid, and early reached a maximum of two flowers per plant per day around day 80. The decline and recovery of the growth rate is reflected in the flowering, which reached a second maximum on day 95.

In 1924-25 flowering began later, and only reached a maximum of 1.5 flowers per plant per day, on day 85, and had virtually ceased on day 110.

In 1925-26 flowering began still later, and did not reach its maximum until 95th day. It continued later than in the two previous seasons, and did not finish until day 126. From the growth curve, then, we can predict the time of maximum flower production, and can tell roughly what maximum to expect, but, what is more important, we can tell with fair accuracy when flowering will be finished. Expressed in another way, cessation of increase in height foretells cessation in flowering twenty-one days later. Since the mean period from flowering to bolting is constant, at fifty-three days for the strain BF, it follows that one can forecast the finish of bolting by seventy-four days—i.e., we know, ten weeks in advance, when the crop will be finished.

Shedding Records (Fig. 7B.).—The amount of boll shedding differs enormously in the three seasons. In 1923-24, on the 98th day after flowering, it rose to the alarming rate of 1.8 bolls shed per plant per day. In 1924-25 the amount was very small, and in 1925-26 was almost insignificant. It seems probable that there is a distinct positive correlation between the number of bolls shed and the number of flowers produced, a plant with a large number of flowers, producing as it were to the limit of its capacity, being more than usually susceptible to any physiological strain that it may suffer at the hands of the environment.

The Bolling Records (Fig. 7B.).—These great variations in shedding rates have their effect on the bolting rates, and prevent any reasonable forecast of the crop being made from the flowering curves (see L. H. B., *Trop. Agric.*, Vol. II., No. 4). In October 1924-25, when comparing the flowering rates with the previous season, we naturally expected that bolting would be much less, but it turned out that the small amount of shedding had compensated for the few flowers produced, with the result that the bolting rates for the two seasons were substantially the same.

In 1925-26, as was to be expected from the flowering records, the bolting period was unusually long, though the maximum did not rise above one boll per plant per day.

Summing up the results from a practical point of view, we may say, then, that:

1. The most useful feature for forecasting in the West Indies is the growth curve. From it we know what kind of flowering curve to expect, and can tell when the crop will be finished.

2. The flowering curve gives more evidence as to time of beginning and ending of crop, but is of no use in foretelling size of crop, since one cannot foretell what losses will intervene between flowering and bolling.

3. The shedding curves account for some but not all of the above losses. Taken in conjunction with flowering, they should throw some light on the probable bolling rates.

4. The bolling rates are invaluable as a yield record, but give little if any other information.

These results are in direct contrast to those of Balls in Egypt,⁵ who found that boll shedding was approximately constant at 40 per cent. from year to year, and thus the size of crop could be forecasted with some accuracy from the flowering records.

The Contents of the Bolls : Seed Weight, Lint Weight, and Lint Length (Fig. 8).—The actual determinations were made as follows: For each daily sample the number of seeds taken to weigh 20 grammes was counted. These were then ginned, and the lint weighed to the nearest hundredth of a gramme. Simple slide-rule calculations then give the weight of lint per 100 seeds and the weight of 100 ginned seeds. The ginning outturn, or percentage of lint to lint plus seed, which is clearly a function of lint weight and seed weight, can, if required, be obtained by simple multiplication.

Seed Weight.—The daily variations of this character are very similar indeed for all three years, except for the last ten days of the crop.

The seed weight is the highest at the beginning of the crop and gradually falls until about the 35th day. After this there would appear to be a slight recovery if the bolling period is long enough. A gradual depreciation in lint length through the season was also noticed by Balls in Egypt,⁷ there being, however, no recovery at the end of the period. The fact that we get a similar depreciation in seed weight, not only in three seasons in St. Vincent, but also in Egypt, renders it practically certain that the variation is *not* due to the environment. A similarity of climatic conditions for three different West Indian seasons and for Egypt is almost inconceivable.

Lint Weight.—This character shows considerable differences in fluctuations from year to year, by far the most variable being 1923-24. Variations in lint weight have been shown to be due to variations in

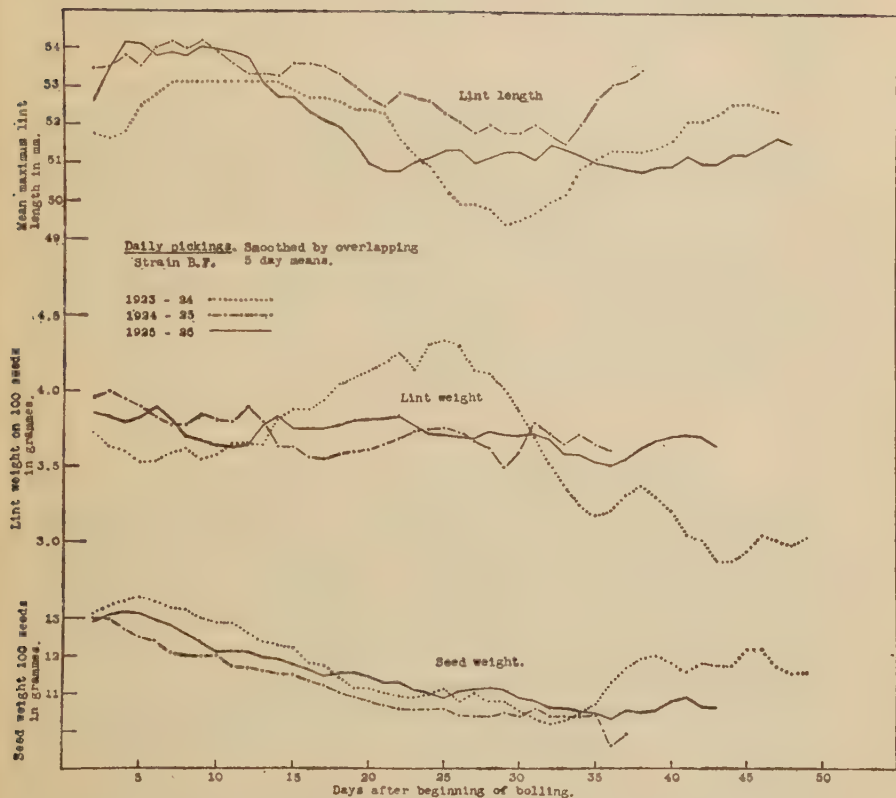


FIG. 8.—ANALYSES OF BOLL CONTENTS, ST. VINCENT

number of hairs per seed (Balls,² Leake,¹¹ L. H. B.⁸). This number is presumably settled at or shortly before the time of flowering, and hence one must look for the cause of these lint weight variations in the state of the environment at this time. In 1924-25 there was a close negative correlation with rainfall, but there was no evidence of this in the two other years. It is, of course, absurd to use direct rainfall data in this way, as they cannot be expected to show the real state of affairs as regards soil moisture and oxygen content.

Lint Length.—This character is also variable. In all three seasons there is a tendency for the shortest lint to be produced towards the middle of the season, probably for physiological reasons, since at this time the plant is maturing the greatest number of bolls. This depression was unusually marked in 1923-24, and in this year there was a close negative correlation between rainfall nineteen days after sowing and subsequent lint length¹¹ (see L. H. B., *Empire Cotton Growing Review*, Vol. II., No. 3). This correlation, however, did not recur in the following season, and it is clear that further research with facilities for the controlled conditions of soil moisture is necessary.

THE BALLS SLEDGE SORTER (see Fig. 9).

It was felt that our small laboratory gin was possibly breaking some of the lint hairs, and that sorter results might be showing an excess of short hairs for this reason. Accordingly, two identical samples of strain V135 were prepared by picking out seeds one at a time from a heap of seed cotton. One of these two samples was then delinted very carefully by hand, and the other was ginned in the ordinary way. Both samples were then sorted, using special care in the preparation of the sliver, making two separate strippings for each.

The accompanying curves show the results obtained. From them it seems perfectly clear that the gin does actually break an appreciable portion of the long hairs. The difference between the two samples, however, is slight, and the whole is a good example of the precision which can be obtained when the machine is carefully handled.

Further use of the machine on the lines suggested by the author in (8) has had to be abandoned for lack of time.

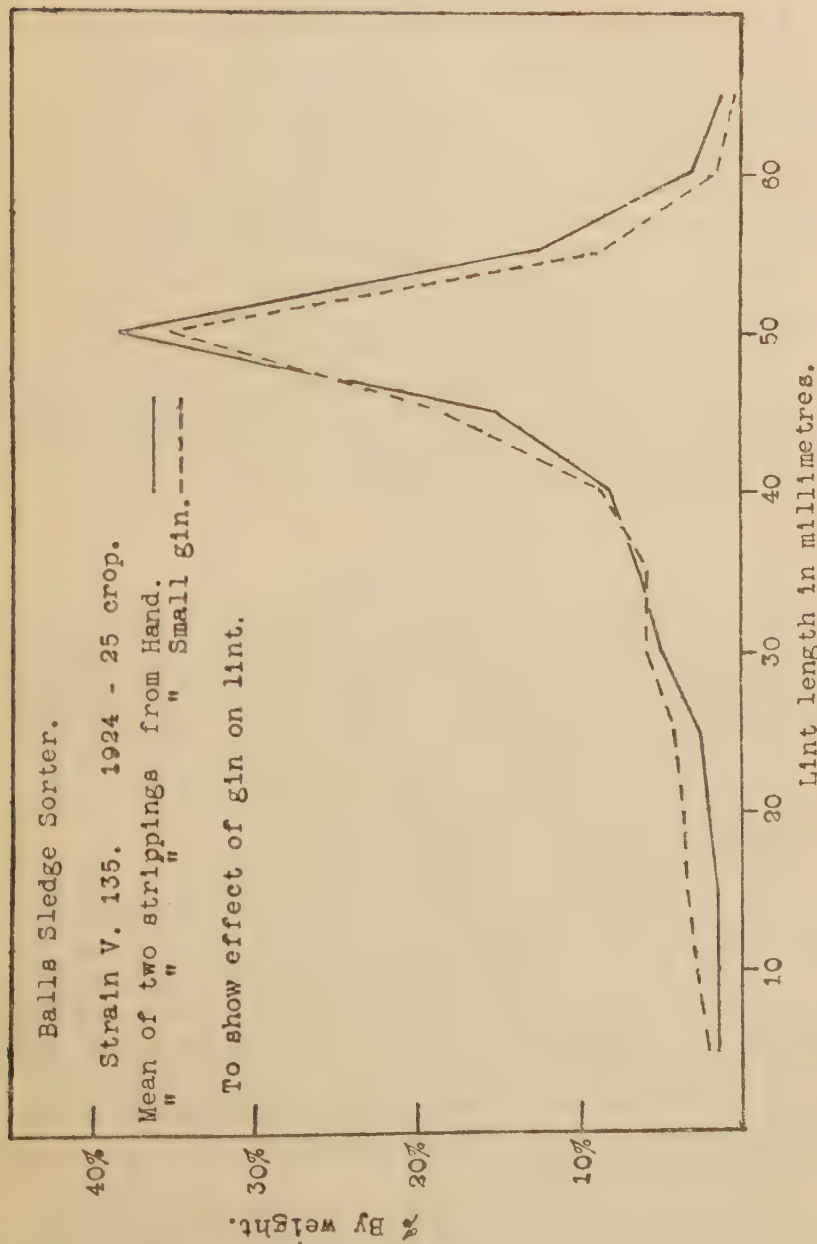


FIG. 9.

NATURAL CROSSING.

It is well known that natural crossing takes place with fair regularity in commercial cottons. Balls in Egypt¹ found the amount to be about 13 per cent., and the question has also been examined in India and America (see H. A. Allard and H. M. Leake), but so far as the author is aware no direct test has ever been made with Sea Island Cotton in the West Indies. As noted elsewhere in this report, we have now a pure strain with pure white flowers, which, on being crossed with a variety having yellow flowers, gives an intermediate F1.

By using this strain all chance vicinists can easily and accurately be spotted by their flower colour in the next generation.

In order to make this test, eight rows of the white-flowered type were grown alternately with rows of the strain AJ with full yellow flowers. The number of plants with pale yellow flowers which appear in the white stock next year will tell us the amount of natural crossing which takes place between the adjacent rows.

THE PURE STRAINS.

Our pure strains have been continued, and observations of lint length, lint weight and seed weight have been made a matter of routine each year. An extensive variety test was carried out with them in 1923, and this has already been reported.⁹ These strains were, it is believed, originally isolated by Dr. Harland in 1916 or 1917, and it is probable that they have now reached a state of purity which has not been approached with other cottons elsewhere. Crucial statistical evidence of this is, however, lacking.

A summary of the principal data for the last four years is given in the table. From this the outstanding feature of the present season is the decrease in seed weight. This, however, was not shown to anything like the same extent by the daily pickings, and it is not very easy to reconcile the two sets of data; while we have no evidence to support it, it seems probable that the pickings of the pure strains in the three earlier years were made at the beginning of the bolling period, while in 1925-26 they were not made until some three or four weeks later when the seed weight had declined considerably (*vide* Daily Picking Curves, Fig. 8).

It may be of interest to record that of these pure strains V135 has now been grown commercially on one estate for several seasons (at least three), and that steps are being taken by the local department to distribute AN next year

PURE STRAINS.
SUMMARY OF PRINCIPAL DATA FOR FOUR SEASONS.

	Lint Length.				Lint Weight.				Seed Weight.				Out-turn.				
	1922-23.	1923-24.	1924-25.	1925-26.	1922-23.	1923-24.	1924-25.	1925-26.	1922-23.	1923-24.	1924-25.	1925-26.	1922-23.	1923-24.	1924-25.	1925-26.	
V135	..	56.7	52.9	56.6	54.7	4.00	3.80	3.96	3.60	12.3	13.6	12.9	11.1	24.5	21.9	23.9	24.1
BD	..	51.5	50.6	51.4	49.5	4.80	4.26	5.22	4.3	12.4	13.0	13.6	10.0	27.9	24.7	28.4	28.5
BF	..	53.0	49.5	52.5	52.9	4.26	3.70	3.90	3.72	12.3	13.5	14.0	10.5	25.7	21.3	21.7	25.6
AE	..	51.5	50.8	52.1	52.3	4.78	4.49	3.48	—	12.8	14.2	15.0	—	27.2	24.0	25.1	—
AN	..	50.3	50.3	50.9	51.0	5.45	4.71	5.25	4.46	11.5	12.5	15.2	10.0	32.0	27.1	25.5	30.9
G×12V	..	52.4	50.0	53.2	52.8	4.00	3.20	3.91	3.22	12.6	12.7	16.1	11.2	24.0	20.1	19.6	22.4
G×12	..	51.8	47.7	50.6	49.4	4.77	4.52	5.01	4.24	12.4	13.6	15.0	11.2	27.8	24.9	25.1	27.4
AJ	..	51.5	51.3	51.0	50.4	5.36	5.04	5.77	4.53	11.3	13.3	13.6	10.7	32.2	27.4	29.7	29.9

Lint length = mean maximum in millimetres.
 Lint weight = weight on 100 seeds in grammes.
 Seed weight = weight of 100 seeds (ginned) in grammes.
 Out-turn = percentage of lint to lint plus seed.

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